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THE GOLD MINES OF THE WITWATERSRAND, SOUTH AFRICA.

By John Hays Hammond.

II.—PROBABLE VALUE, APPROXIMATE DURATION, AND MINING LAWS OF THE REGION.

IN my preceding paper, discussing the geology of the Rand, I defined the several reefs constituting the workable ore bodies of the portion of the region under description. While there is, compared with other auriferous reef deposits, a remarkable uniformity in the width and richness of the reefs, they are by no means homogeneous in respect of these features. The pay-ore occurs chiefly in large patches or zones, though sometimes in well-defined shoots. The intervening portions of the reefs, while usually auriferous, are of considerably less value than the pay zones referred to. The same condition of ore-occurrence obtains in following the reefs in depth, but, as far as we are able to judge from past experience, which extends to the development of an aggregate of upwards of one hundred miles upon the reefs, the occurrence of poorer zones seems to be compensated for by the recurrence of richer zones.

On the other hand, comparison between more remote claims shows great differences in their relative values. As may be inferred from the above description, the percentage of non-payable ore in a claim varies in different parts of the Rand. Concurrently with reduced working costs, which are gradually being effected, the payable zones become extended, and the percentage of barren patches correspondingly diminished. While it is difficult to arrive at an approximation of the relative amount of non-payable and payable ground, I think a conservative estimate would be that upon the payable reefs of

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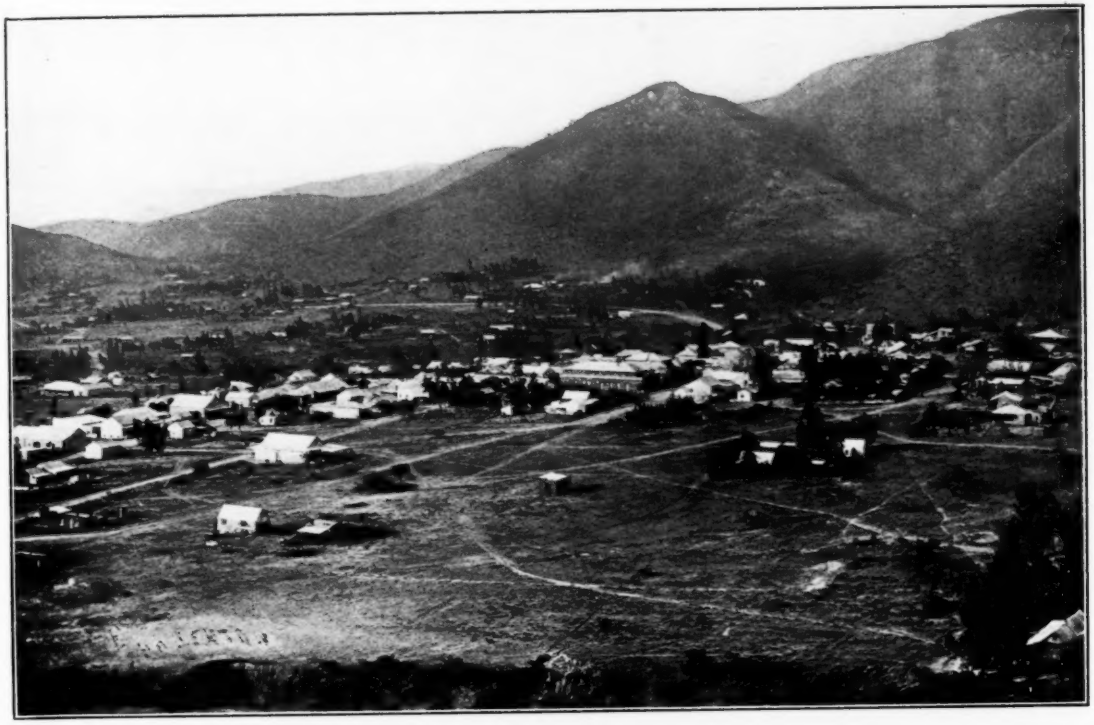

GENERAL VIEW OF BARBERTON, THE PIONEER REEF GOLD-MINING CITY OF SOUTH AFRICA.

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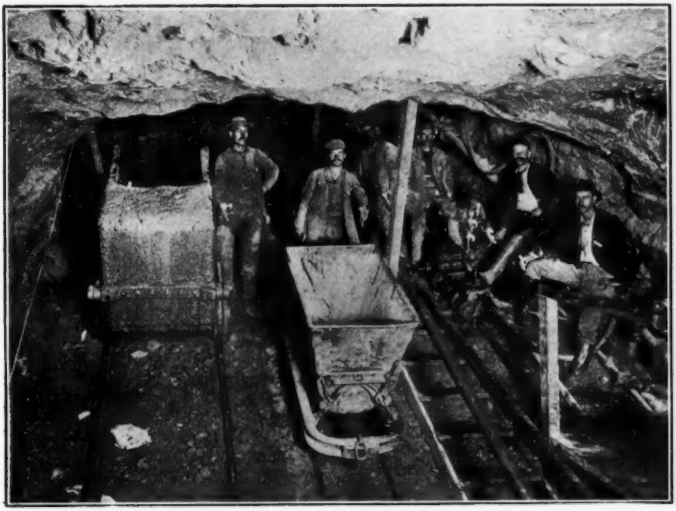
the central section of the district two-thirds of the ground opened up may be mined with profit. To those unfamiliar with the unique conditions of the Witwatersrand deposits, the estimates made by mining engineers as to the gold contents of the reefs seem hazardous on account of the apparently inadequate developments. Careful engineers, as the result of extensive experience upon the Rand, however, have estimated the gold contents of the central section of this district, which embraces an extent of 11½ miles along the course of the reef within workable depths, at £400,000,000. Estimates of the gold contents of the reefs to the east and west of this section are confessedly more unreliable, although Dr. Hatch computes the available



AN INCLINE SHAFT IN THE SIMMER AND JACK MINE, 800 FEET UNDERGROUND.
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gold from these portions of the Rand at £200,000,000. To apprehend the large quantity of estimable gold of the Rand, it may be stated that the entire output of the auriferous gravels and of the quartz veins of California, from the inception of mining operations to the year 1886, is about $1,280,000,000—a little more than one-half that of the central section just referred to.

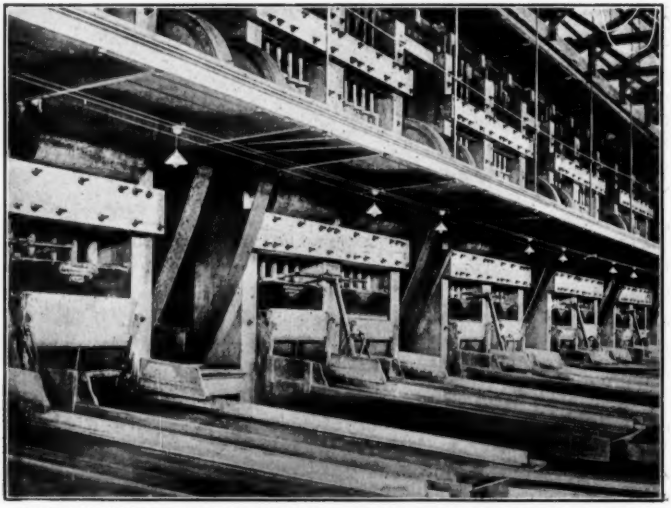
Curiously enough, by far the most valuable portion of the Witwatersrand deposits is in the immediate vicinity of Johannesburg, though the location of the town was not determined with respect to the supposed position of the richer section of the district.

The following table shows the total gold production of the Witwatersrand:

Year.	Ounces.	Dwts.	
1887.....	23,125.	8	
1888.....	208,121.	14	
1889.....	369,557.	5	
	42,000.	0	estimated unrecorded production for 1887, 1888, 1889.
1890.....	494,817.	0	
1891.....	729,268.	6	
1892.....	1,210,868.	16	
1893.....	1,478,477.	3	
1894.....	2,024,163.	12	
1895.....	2,277,640.	4	
1896.....	2,280,892.	4	
Total.....	11,138,931.	12	

During the first ten months of 1897 2,427,838 ounces have been recovered, and the probable output (estimating the returns for November and December) for the year 1897 will be 3,000,000 ounces.

The stamping capacity of the Rand has been considerably in-



INTERIOR OF A BATTERY, CROWN REEF GOLD-MINING CO. LTD., JOHANNESBURG.
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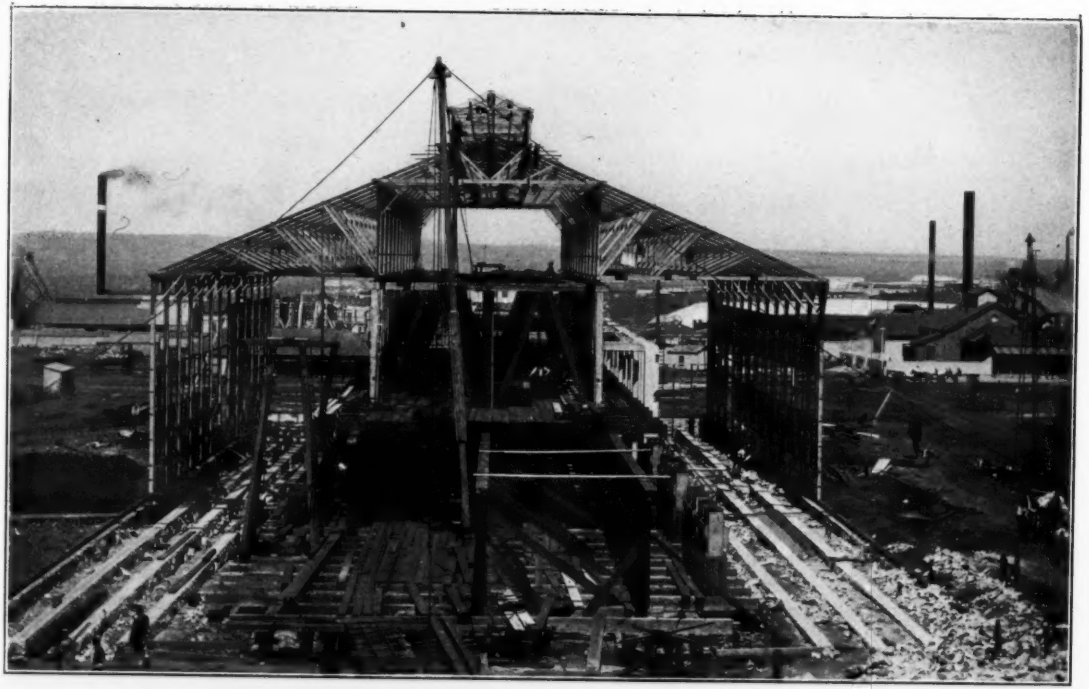
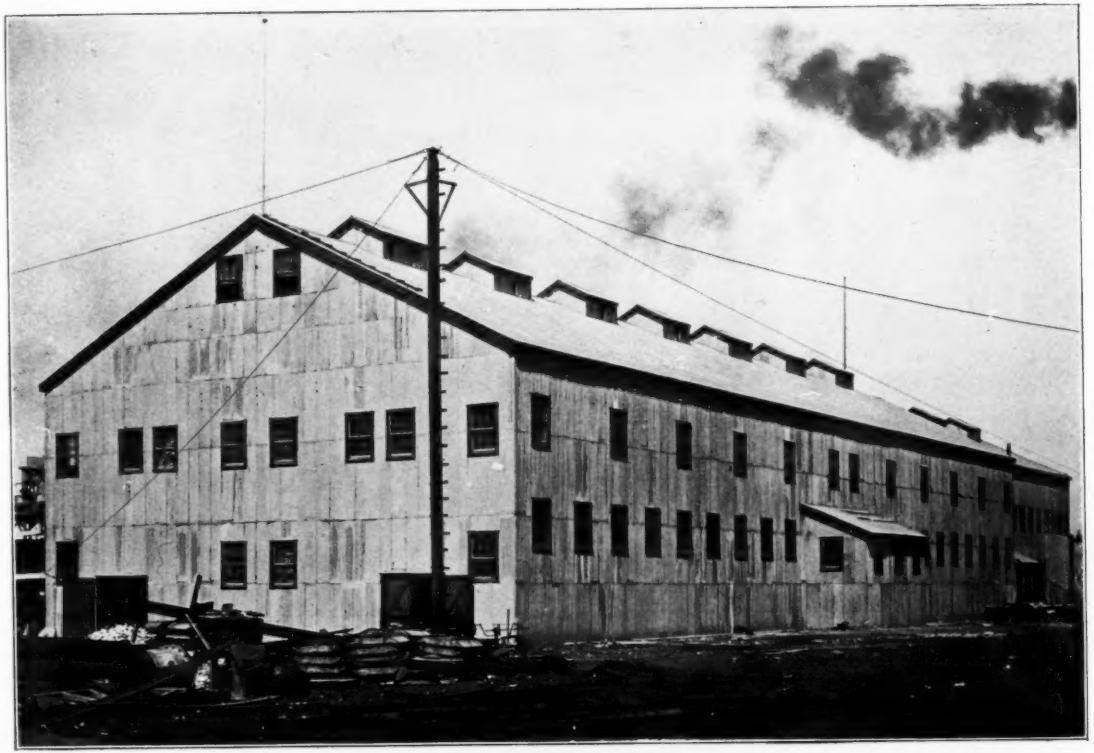


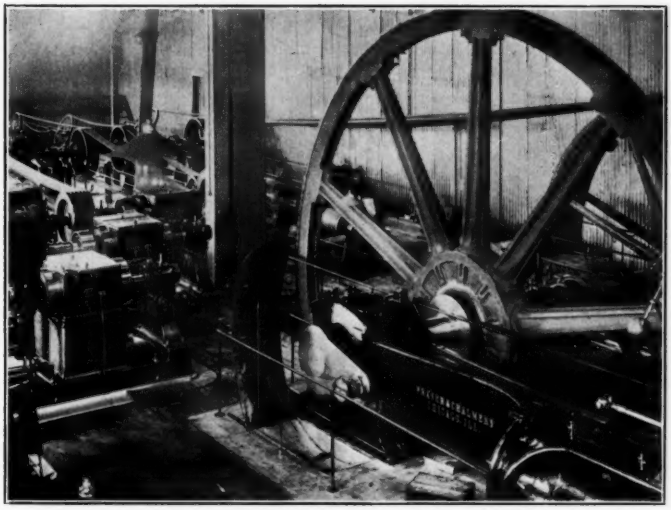
NEW 280-STAMP BATTERY AT THE SIMMER AND JACK MINES—THE LARGEST IN THE WORLD.



STAMP MILL, CROWN DEEP MINE.

creased during the past year; to-day there are 4,635 stamps. A large percentage of these stamps have been erected upon low-grade properties in what is called the outside districts of the Rand principally, and will not be able to crush profitably unless considerable economic reforms are made by the government. These reforms have been urged by the burghers themselves, and must ultimately be granted.

Including the stamps in course of erection, and those whose immediate erection is contemplated, the number of stamps is about 5,700. Other properties will be developed, and the stamping power further increased, in the event of future reductions in mining costs, with the



ENGINE AND DYNAMO ROOM, CROWN REEF BATTERY.
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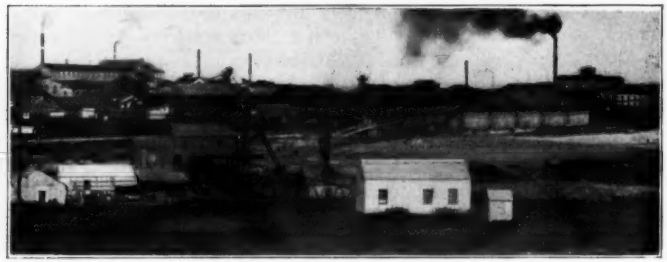
result that within a few years the annual output of the Rand will probably exceed £20,000,000.

In the year 1896 in the Witwatersrand district 2,949 stamps were in operation, crushing 4,011,697 tons (of 2,000 pounds) during 308.65 days' milling. This is a stamp-capacity per diem of 4.4 tons. The mill yield was 1,501,492 ounces, equal to 7.48 dwts. per ton, having a value of £5,381,600, or £1. 6s. 10d.* per ton of ore crushed. The concentrates yielded 107,890 ounces the value being £393,736. The tailings yielded 662,998 ounces, equal to 4.72 dwts. per ton, having a value of £2,058,851, or 14s. 8d. per ton of ore milled.

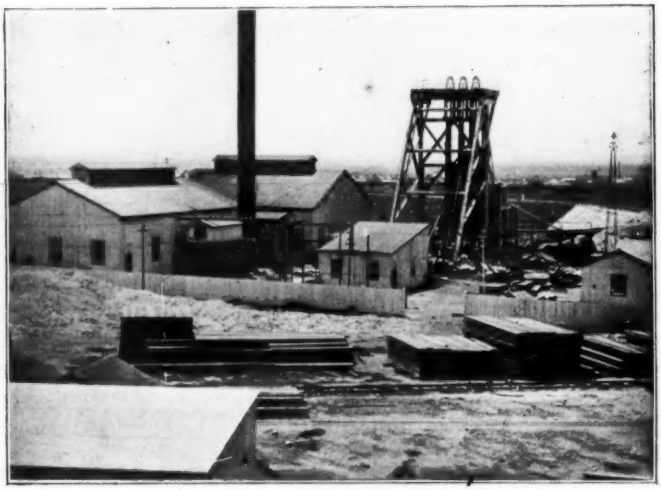
* Equal to $6.51 at the current rate of exchange, $4.85 for £1 sterling.



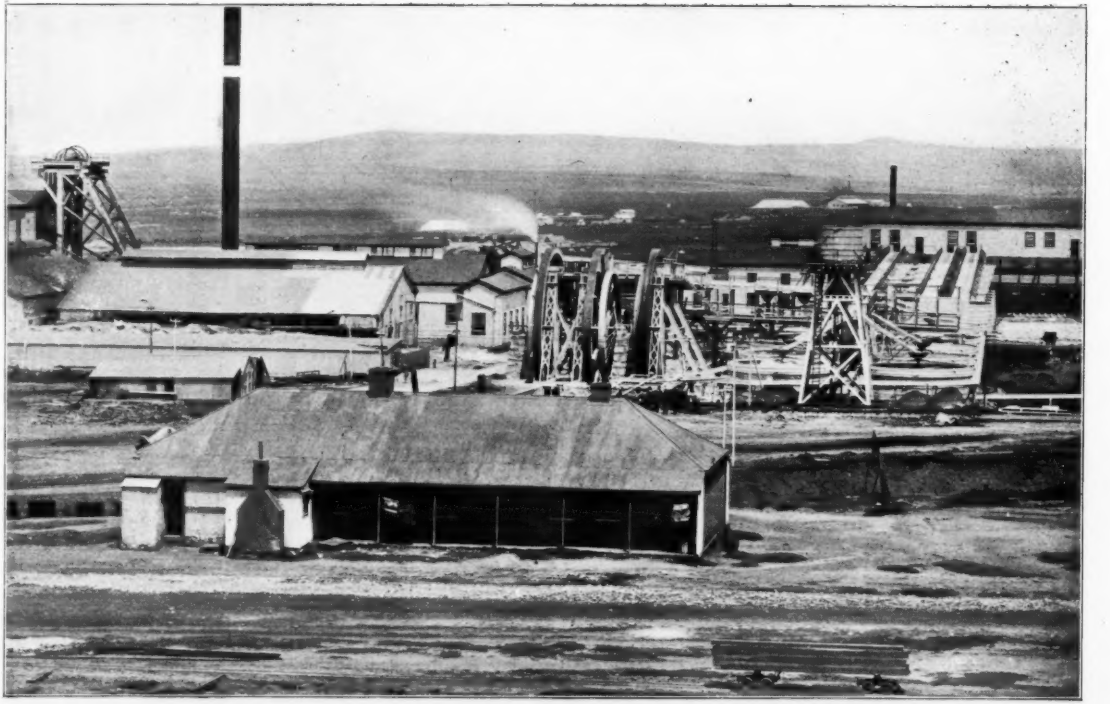
THE SIMMER AND JACK MINES, JOHANNESBURG, LOOKING EAST.

It is impossible to make any approximation of the life of the district, as the elements of uncertainty as to the feasible depth of future mining operations, the rapidity of exploitation, and other important points, are still indeterminate. Regarding the life of the Rand, I reiterate the opinion I expressed in an article contributed to the *North American Review* of February, 1897, wherein I said:

> Actual mining developments upon the deep-level areas, supplemented in turn by the results of the borehole explorations, confirm the theories advanced by the geologists, and justify the predictions that the life of the Witwatersrand district, from a mining point of view, is a long one; how long, though, it is impossible to accurately predict, having at present the indeterminate factors of the possible depth to which mining operations can be prosecuted, and of the rate of future annual exploitation.



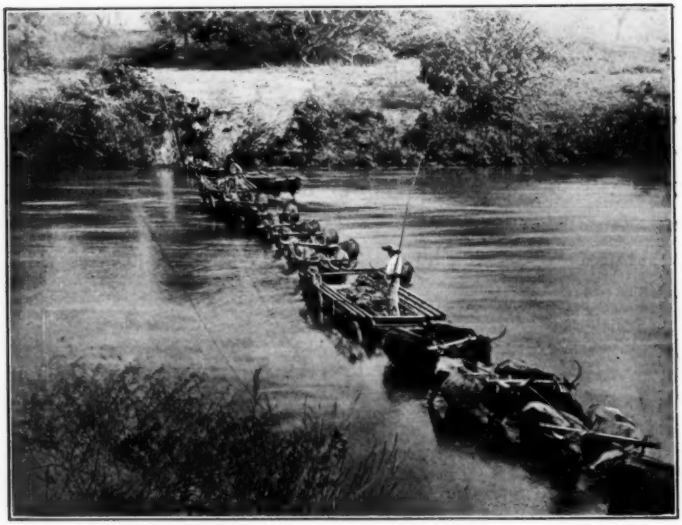
NO 3. SHAFT. SIMMER AND JACK MINES.



THE SIMMER AND JACK CYANID WORKS.

To speak of the illimitable ore-deposits is, of course, hyperbole, but it will certainly take three decades, perhaps more, to exhaust the deposits of the central section to the depth to which mining operations are now considered practicable. The inevitable reduction of costs of future mining and the discovery of other payable deposits would undoubtedly tend to increase the longevity of the district. On the other hand, it is obvious that, if the developments of the lower areas should proceed more or less concurrently with, and not as the sequel of, the exploitations of the upper horizons, the life of the district will be correspondingly shortened.

The rapidity of the development must, of course, be dependent to some extent upon the future mining laws of the country. Reference was made in the first article to the former statutes. The tenor of the existing laws can best be indicated by some extracts and abstracts, which follow:



CROSSING A RIVER IN THE TRANSVAAL.
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"The right of mining for and disposing of all precious metals and precious stones belongs to the State, but the State president, with the advice and consent of the executive council, may, by proclamation, throw open government ground as public diggings, upon which mining claims can be pegged off as specified by law."

An owner of a farm may, upon application to the government, have the farm likewise proclaimed. Before proclamation of a private farm the owner has the right of allotting to any person or persons he may specify a certain number of claims, called Vergunning claims,

NO. 1 SHAFT, ROBINSON DEEP MINE.

the number depending upon the size of the farm, but not to exceed a maximum of sixty.

The owner has the further right to reserve for himself for mining purposes one-tenth of the ground which is called a Mynpacht. This portion is held as a lease by the owner, under what is called Mynpacht brief, for a term of not less than five years, or more than twenty years, with the right of renewal. The rental on Mynpacht is 10s. per morgen (2.11 acres). A reef claim is 100 Cape feet (103.3 English feet), measured in the direction of the strike of the reef, by 400 Cape feet (413 English feet) in the direction of the dip of the reef,—equal to about 1½ acres.

The owner of the farm may also retain a certain area for residential and farming purposes, called a "werf" or "Homestead." The owner of a proclaimed farm is entitled to one-half of all licenses paid to the government.

Prospecting is not allowed on private ground without permission of the owner, but public government ground is open to prospectors, though claims may not be pegged out until after proclamation of the ground in question, as above described.

On private ground there is a charge of 5s. per month per claim for prospecting license, half of which goes to the owner, the government receiving the other half. On government ground there is a charge of 2s. 6d. per month, which goes to the government.

When, in the judgment of the mining commissioner, the results of the explorations justify, he may convert the prospecting licenses into a digger's license, after which a charge of 20s. per claim per month is made, provided ore is being crushed from the property. If, however, no ore is being extracted and crushed from the claim, the charge for the digger's license is 15s. per month.

For 1896 prospecting licenses amounted to.....	£620,000
digger's licenses.....	61,000
machine stand licenses.....	59,000

By the amalgamation of a number of claims, varying from 15 in the case of the smaller companies to 200 in the case of the larger, companies were formed in the first instance, and were called outcrop companies. These companies derived their name from the fact that the claims included the outcrop of the reefs and their contiguous claims. Subsequently the deep-level companies were formed by the amalgamation of residual claims sub-jacent to the outcrop property.

In order to offset the greater initial cost of plant, the deep-level companies embraced a larger number of claims in their area. The majority of these have from 150 to 400 claims.

The term deep-level is obviously a relative one, applied indeed in

PROSPECTORS PANNING FOR GOLD.
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"MUSIC HATH CHARMS," EVEN FOR KAFIR BOYS.

contradistinction to that of outcrop. But few of the present deep-level companies contemplate working through shafts to a greater depth than 2,500 feet. To equip a deep-level property to work at a depth of 3,000 feet with all the necessary shaft sinking, mining plant, and with a battery of 200 stamps, and the appurtenant tailings plant, involves an outlay of about £700,000. Many of the deep-level properties are already in operation, and returning very satisfactory profits.

The economic data of Witwatersrand mining will be given in the series of articles by Messrs. Webb, Yeatman, and Holms, which will appear in regular sequence in THE ENGINEERING MAGAZINE during the next few months. The *résumé* of mining laws on the North American continent, prepared by my friend Dr. Rossiter W. Raymond, which immediately follows in this number of the magazine, affords an interesting standard for comparison with the legislation under which mining is conducted on the Rand.

MINING LAW IN BRITISH COLUMBIA, MEXICO, AND THE UNITED STATES.

By Rossiter W. Raymond.

AS Mr. Hammond remarks in the preceding article, the rapidity of development, and consequently the life, of a mining district must be dependent to a great extent upon the mining laws. Mr. Hammond indicates briefly the tenor of the present and former statutes thus affecting mining on the Rand.

The following brief summary* of mining legislation affords a basis for comparison in judging of the spirit of the laws of the South African republic, and estimating their relative effect.

The United States. The federal law relating to mines applies only to public land in certain States and territories, and concerns only the terms upon which mineral land may be occupied and purchased. Although extremely vague, difficult of construction in many cases, and productive of much uncertainty and litigation between conflicting claimants of title, it is very liberal towards explorers and locators, and, with all its faults, has undoubtedly stimulated an intense activity in prospecting and a consequently rapid, if somewhat wasteful and speculative, development of the mineral resources of the Rocky mountains and the Pacific coast. It is impossible to give here more than a bare outline of the main features of the system, as finally established in 1872.

All mineral deposits in public lands of the United States are free and open to exploration and purchase, by citizens and those who have declared their intention to become such. The discoverer of a mineral deposit (or the re-locator of an abandoned one) stakes out a claim, and records his location thereof, on payment of a trifling fee. (Special privileges are granted to discoverers of veins by tunnels.) Lode-claims (containing veins or lodes of quartz or other rock in place, bearing valuable mineral) cannot exceed 1,500 feet in length, or 300 feet in width on each side of the vein at the surface, or be restricted to less than 25 feet on each side the vein, unless pre-existing rights make this necessary. Placer-claims (containing any other form of deposit except "lodes") are limited to 20 acres for individuals and 160 for associations. Lode locators enjoy possession of the surface, and the ownership, to any depth, of all veins the apexes (upper

* The publishers, at Mr. Hammond's suggestion, have obtained from Dr. Rossiter W. Raymond, secretary of the American Institute of Mining Engineers, the accompanying abstract of the mining laws of the United States, Mexico, and British Columbia. Dr. Raymond desires it to be understood that, by reason of the limited space available, his summary is necessarily far from comprehensive.

edges) of which lie vertically under it, though the veins thus owned pass downward into adjoining lands. This so-called extra-lateral right is attended with a corresponding deduction from the title of the locator,—that is to say, the ownership of veins entering his land is vested in the owners of the locations which contain their apexes. Moreover, the extra-lateral right is dependent upon certain conditions in the location. This must have parallel end-lines, vertical planes through which are the boundaries of the said right. Until a locator has proceeded to purchase outright, he holds his claim by possessory title, subject to the fulfillment of local regulations. In this respect, the federal law makes but one regulation—that the amount of work annually done on each claim shall be not less in value than $100. Failure to observe these conditions forfeits the claim without any official notice, leaving the land open to occupation and re-location.

A complete title is obtained by application for a United States mineral land patent, survey by a government surveyor, advertisement of the application for 90 days, proof of the expenditure of not less than $500 in labor or improvements on the claim, and payment of $5 per acre and fees. If no adverse claim is filed during the period of advertisement, a patent issues upon the fulfillment of the other conditions named. The patent confirms, and renders independent of annual "assessment-work," the rights and privileges previously held under possessory title by the locator. In case of an adverse claim, the proceedings of the United States land office are suspended, until the adverse claim has been adjudicated by a court; a suit for that purpose must to be brought by the adverse claimant within 30 days.

No limit is set to the number of locations which may be held by one owner, and there is no restriction upon the transfer of possessory titles, or interests therein. Indeed, the mere fact of location withdraws the land from the public domain, and the holder of a patent is a private owner of real estate in fee, and, as such, can do what he likes with his property. Provision is also made for the location and purchase of mill-sites.

The price for placer-claims is $2.50 per acre. Coal-lands and salines are sold like agricultural lands, but at special prices.

It will be seen that the law grants the utmost freedom to explorers and miners, and that (apart from the trifling price per acre of claims patented) the government does not attempt to derive from its mineral lands any revenue. Mining is placed in this respect on the same footing as all other industries.

Mexico. The famous ordinances decreed in 1783 by the king of Spain are said to have been in some respects a codification of Aztec mining customs. After the establishment of Mexican independence,

mining legislation was left largely to the several States, with much confusion as the result. In 1883 the States adopted an amendment to the constitution, authorizing the federal government to regulate mining for the whole republic. The mining code of 1884, framed under this authority, was an advance upon the previous condition of mining law in Mexico; but it was cumbered with minute details, harassing and discouraging to investors and adventurers. A more liberal statute came into operation July 1, 1892, and is now in force. Under this statute mines of gold, silver, platinum, mercury, iron, lead, copper, tin, zinc, antimony, nickel, cobalt, manganese, bismuth and arsenic, precious stones, rock-salt, and sulphur are granted by concession. Mineral fuel, mineral oils and waters, building materials, sand, clay, etc., and substances not included in the concessionary list, are the property of the owner of the soil, and may be worked freely without any concession. Mine-workings of both classes, however, are subject to State inspection and regulation. Any inhabitant of the republic may hold mining property. There is no distinction against aliens. Mining titles under concessions are perpetual and irrevocable, so long as the federal tax is paid. Such titles may be freely assigned and transferred, provided due report and registry of the change of ownership be made.

The unit of concession is always a vertical prism of indefinite depth, having for its external base a surface-square 100 meters on each side. This unit is indivisible. In cases where, between new concessions and older ones, space is left smaller than one unit, that space is also granted to the first applicant. In the granting of concessions, the explorer and discoverer of a new mine has preference, if he applies before the actual grant has been made. Otherwise, priority of application governs; and the applicant can have as many units as he is willing to pay for, so far as ungranted ground is available. The concession does not carry surface-ownership. But the mine-owner may occupy any surface land needed for mining. If it be private land, he must agree with the owners as to the terms of his use of it. If such agreement cannot be made, proceedings for legal condemnation are taken. The payments exacted are as follows. The *concessionaire* must pay $10 per unit (10,000 square meters) of his concession at the time of its issue. This is a stamp-tax, stamps to the required amount being placed on the patent issued to him. He must also pay an annual tax of $10 per unit, in three equal parts during the year, under penalty of fines and forfeiture. Finally, he must pay (with the exceptions specified below) an annual tax of 2 per cent. on the products of mining, without deduction for expenses. Mines of stone, coal, petroleum, iron, and quicksilver are exempt from this tax.

Metallurgical works and shops may be taxed up to $6 per $1,000 upon the value of their real estate and machinery.

On the public land, prospecting by boring, or by excavations not exceeding ten meters in depth, is free to all inhabitants of the republic. On private land the consent of the owner, or else a special executive permission, granted after due hearing, and upon security for damages, is required. The owner alone can authorize prospecting within buildings or their dependencies, and it is not permitted in towns. All mine-workings must conform to the rules made to secure safety and permanency. Otherwise, the owners have entire liberty, being responsible for accidents or damages caused by their neglect.

British Columbia. Like other provinces of Canada, British Columbia has its own mining laws. Omitting here the coal acts of 1888, and the act of 1897 for the inspection of mines to secure the safety and health of workmen, we have the placer mining act of 1891, amended in 1894, 1895, and 1896, and the mineral act of 1896, amended in 1897. According to these statutes, every "free miner"—*i.e.*, person or company holding a free-miner's certificate, which costs $5 per annum for an individual, $50 for a company having a nominal capital not exceeding $100,000, and $100 for one having larger capital—has the right to enter, locate, prospect, and mine upon any waste lands of the crown for all minerals except coal. In certain cases, where the lands are already lawfully occupied for other purposes (though the rights as to gold and silver have been reserved by the crown), he may be required to give security and pay damages to the prior occupants or owners.

Any free miner may locate a claim, as nearly as practicable, and not exceeding, 1,500 feet long by 1,500 feet wide; the form to be rectangular, unless pre-established boundaries interfere. The claim must be suitably marked with posts, and particulars thereof, together with affidavit of the discovery of mineral in place, must be furnished to the mining recorder for record. The holder of a claim is entitled to all minerals within it, but not to anything outside vertical planes drawn through its boundaries. (From 1884 to 1892 the British Columbia law was a practical copy of that of the United States, and granted claims 1,500 by 600 feet in size, with the attached extra-lateral right. There is still some litigation over the rights thus given to old locations, but the source of such trouble has been wisely closed.) The record entitles the locator to hold the claim for one year, and thereafter from year to year without re-recording, provided he keeps his miner's certificate in force and files proof of $100 worth of work done in each year, or pays $100 in lieu thereof, and records the official certificate of such facts. A lapse in respect to either of

these two certificates forfeits all rights, and the claim is deemed vacant and abandoned. The interest of a free miner in his claim is a chattel interest, equivalent to a lease for one year, renewable from year to year, and subject to performance of the conditions of the act.

Any lawful holder of a mineral claim may obtain a crown grant therefor on the following conditions: (*a*) improvements to the value of $500 on the claim, or a payment of $500 in lieu thereof; (*b*) proof of the finding of a vein—*i.e.*, a body of valuable mineral-bearing rock in place—within the claim; (*c*) survey by a Provincial surveyor; (*d*) posting and advertisement of notice to apply for a grant after 60 days; (*d, e, f, g, h*) issue, after due filing of papers required, and in the absence of adverse claim within 60 days, of a "certificate of improvements." (Adverse claims suspend these proceedings, and must be pushed promptly and with diligence to judicial determination.) Upon the granting and recording of this certificate, the claim-holder is entitled to a crown grant of the claim on payment of $5 per acre, provided he applies for the same within three months. The crown grant for a mineral claim carries the mineral right and the use and possession of the surface (including timber) so far as necessary for mining. The other surface-rights are reserved to the crown or to the private owner, but the grantee of the mineral claim may purchase the complete surface-title besides, if the land be unoccupied, for $5 per acre. Crown grants for mill sites not exceeding 5 acres may be similarly had at $5 per acre; but these grants reserve the mineral right to the crown. It will be seen that, with regard to crown lands, the law contemplates the mineral right and the soil-ownership as two separate estates, and values each at $5 per acre, for sale under certain conditions to qualified applicants.

Placer claims are divided into creek claims, bar-diggings, dry diggings, bench-diggings, and hill-diggings. A creek-claim is 100 feet long and 100 feet wide—or more, if the distance across the creek from bench to bench is greater. In bar-diggings a claim is 100 feet long at high-water mark, and in width extends from high-water to low-water. In dry diggings and bench-diggings a claim is 100 feet square; and, in hill-diggings, it has a frontage of 100 feet along the ravine, and extends back to the summit of the hill. Larger claims are allowed to first discoverers. Placer-miners must have free miners' certificates. Claims must be recorded and re-recorded at $2.50 per annum, and must be worked every season, unless leave of absence is granted.

No direct tax or royalty is levied in British Columbia on the product of the mines, but all miners, whether employers or employed, must keep their miners' certificates in force. These may be paid for by a company, the amount being deducted from wages due.

THE ECONOMICAL UTILIZATION OF EXHAUST STEAM.

By Bryan Donkin.

THIS is a subject to which, in view of its great importance, sufficient attention is rarely paid, and in many mills and factories much waste is allowed. It is seldom remembered that it is necessary to economize heat when generated, as well as the coal used to produce it, and there is no more efficient means of doing this than to return some of the heat in the exhaust steam to the boilers. In power stations and plants where fuel is dear, costing, say, from 15s. to 25s. a ton, an important reduction in the consumption of coal, and hence an increased evaporative efficiency, results from the utilization of the exhaust steam to heat the feed-water, after it has done work in the cylinder. Either the exhaust from a single-cylinder engine, or from one of the last cylinders of a compound or triple engine, may be made to part with some of its heat, on its way to the condenser.

The most obvious method of accomplishing this object is to condense the whole, or part, of the steam, and produce a vacuum, thus obtaining more power from the engine, as compared with a non condensing plant, and reducing the fuel-consumption. To add a condenser to an existing engine generally results, in practice, if properly carried out, in a gain of 25 per cent. in steam-consumption. A mill proprietor in any locality may justly inquire of the engineer if the addition of a condensing plant will pay for the extra outlay incurred, including the air and water pumps, condenser, increased wear and tear, power and fuel required annually, etc. This will depend upon the local conditions, price of fuel, and whether water for the condenser can be had cheaply or for nothing. In most cases it has to be pumped, and this involves a small additional expense per year for the power required. All these circumstances should be considered before a decision is made.

Condensing plants may be divided into three types:

1. Jet condensers.

2. Surface condensers (marine type), the tubes being cooled by water.

3. Surface condensers exposed to the air, with both air and water circulating around the tubes to cool them.

Each of these three types requires an air pump.

Jet Condenser.—This is the old arrangement introduced by Watt; when used for mill purposes, it generally necessitates about 30 pounds of water per i. h. p. per hour. In this type of condenser the water, when discharged from the air pump, is generally greasy and not very hot, and is scarcely suitable for pumping back as feed-water. Nevertheless part of it is often sent on to the boiler; if not, it is usually run to waste. The quantity of water required is large, and the whole arrangement is uneconomical and seldom desirable. The vacuum obtained, however, is good, often 2 or 2½ inches below atmospheric pressure, and this method of condensing is cheaper than the two others. A water pump is generally necessary, but this depends on the depth at which water is found in the particular locality, and whether any river, pond, or well is available. If the supply is scarce, the same water can be used again and again by passing it through a cooling pond, and this is often done in cotton mills in England. In India and the tropics no great advantage for cooling purposes is gained by this arrangement.

Surface Condenser.—This type is very largely used at sea, on rivers and lakes and in water works; in the last-named case, the cold water is often pumped through the condenser into the mains of the district.

The condenser proper consists of a large number of small brass tubes, through which the exhaust steam is passed, the cold water circulating outside. The quantity of water required is considerable, but at sea or on rivers this presents no difficulty; the water is continually renewed, and no cost is incurred except for pumping. As the feed-water produced by the condensation of the exhaust steam is taken from the inside of the tubes, it is pure water, but contains much or little oil, according to the extent to which the steam cylinders and glands are lubricated. It is not very hot, the temperature being reduced by the cold circulating water. This type is now more often used than formerly on land as well as at sea, but it is dearer, and takes up more room, than the jet condenser. The maximum vacuum should be obtained, and the minimum quantity of cold water used, so that the feed-water may be as hot as possible. There is a good deal of risk in using this condensed steam to feed the boilers, if much oil is supplied to the cylinders, and in many cases on land the system has been abandoned because the grease enters the boilers and forms a coating on the furnace flues, causing them to collapse. Good efficient oil filters are a necessity, but it is extremely difficult with any filter to get all the oil out of the water. The simplest way is to use a minimum quantity in the cylinders, and to measure it out to the engine-drivers. At sea the water is generally circulated by centrifugal pumps driven

COMPARISON OF THREE TYPES OF CONDENSERS.

I.	II.	III.
Jet Condenser (Old Type).	*Water Surface Condenser.*	*Air and Water Surface Condenser.*
Old type on land only.	Marine and land type.	Land type only.
Action.	*Action.*	*Action.*
By direct mixing. Condensed steam and jet of water mixed together and running to waste. Sometimes the water is used again and again from a pond, or tank, and run back into it for cooling.	By transmission of heat. Considerable quantity of circulating water, continually renewed, separate from the condensed steam. Exhaust steam inside the pipes and circulating water outside. Small brass tubes generally used.	By transmission of heat. Small quantity of water running over outside pipes; same water can sometimes be used again and again, if cooled. Condenser placed on roofs of buildings, wind and air having free access. Air propeller often used to cool the pipes, so that there is air as well as water-cooling. Cast iron, steel, or copper pipe is used.
Water-Supply.	*Water-Supply.*	*Water-Supply.*
Large quantity required.	Large quantity circulating water.	Smaller quantity required,—about equal to quantity of steam condensed.
Vacuum.	*Vacuum.*	*Vacuum.*
About 2½ inches under atmospheric pressure. Probable vacuum to be expected in ordinary work, about 27 inches of mercury.	About 3 to 3½ inches under atmospheric pressure, depending on temperature and quantity of circulating water. Probable vacuum to be expected in ordinary work, about 26 inches of mercury.	Often about 3½ to 4 inches under atmospheric pressure, depending on length of exhaust pipe to condenser, and tightness of joints. Varies in every case. Probable vacuum to be expected in ordinary work, about 25 in. of mercury.
Advantages and Drawbacks.	*Advantages and Drawbacks.*	*Advantages and Drawbacks.*
Cheapest first cost. Minimum space required. Large quantity of water, and is greasy after use.	Large quantity of circulating water required. More expensive and bulky than first type. Water from condensed steam greasy.	Less water required than in other types. Main difficulty, to keep joints of exhaust pipes perfectly tight. Condensed steam greasy. External surface pipes should be cleaned frequently from dirt, etc.

An air pump is required for all three types. Water circulating pump required for Types II and III, and often for I a water pump. The practical relative economy of the three types depends entirely on the amount of vacuum that can be obtained in the cylinder of the engine. With very great care they could all produce nearly the same vacuum. No 1 generally gives the highest vacuum; Nos 2 and 3 a much lower one. The choice of the type should be governed by local conditions.

by a special engine, coupled direct. The vacuum usually obtained is some three to four inches below atmospheric pressure. As in this type the circulating water is on one side of the tubes and the condensed steam on the other; the two do not mix as in the jet condenser. The heat is withdrawn from the steam and transmitted through all the tubes to the water, transmission being more or less efficient, according to the condition of the tubes, which are seldom clean. At sea salt water is used for cooling the tubes, and on rivers and lakes this water, whether clean or dirty, is pumped through the condenser.

The third type is also a surface condenser, suitable for land engines and boilers.

Instead of using a large quantity of circulating water, a much smaller amount, about equal to the quantity of steam condensed inside the pipes, is employed. The cold water is forced up by a small pump, and conducted very carefully over the external surfaces of the pipes, so that they may be very uniformly wetted. The pipes are vertical or horizontal, from one to three or four inches in diameter, and the whole apparatus is fixed and worked in the open air. If the situation is not sufficiently exposed to the wind, an air propeller is used, but this requires a little power and fuel. The water is sometimes used again and again, if a pond, or a large tank, can be provided. A certain amount is always evaporated into the air from the hot condensing pipes, and this needs to be replenished. The vacuum obtained is generally less than in the other types, owing to the leakage from the large number of joints in the exhaust pipes. A large number of these condensers are placed on the roofs of buildings in London and the neighborhood, and one of the practical difficulties experienced is to keep the joints tight. The tops of the high buildings in New York and Chicago would be very suitable positions for these condensers, affording plenty of air, but great care would be necessary with the joints to prevent leakage. If this type of condenser is fixed very near dwelling-houses in confined districts, the spray, mist, and fog produced sometimes give rise to complaints.

The characteristics of the three types of condensers, their mode of action, the results secured, and the advantages and drawbacks of each are summed up in tabular form on page 932.

Heating Feed-Water.—Where condensers cannot be applied, and water is expensive and space limited, the heat in the exhaust steam should be utilized for heating the feed-water, instead of condensing the steam.

A large number of feed-water heaters are now at work in England and America, and afford another example of the transmission of heat, though in a different way. They usually consist of a nest of

small tubes with the exhaust steam on one side, the feed-water being pumped through the pipes on the other. In some mills exhaust steam can be used also for heating purposes in winter,—such as warming buildings or drying goods,—and any surplus after condensation should be applied to heating the feed-water, and returned to the boiler, if clean enough. In many of the London electric stations condensers of various types have been added to the formerly non-condensing steam plants, and in others, where no water is available, there are large feed-water heaters, utilizing part of the heat in the exhaust steam. With these appliances a large portion of the exhaust steam still goes to waste.

The question of procuring water cheaply is often one of great difficulty in London and other large cities, and sometimes also space for the surface condensers is not available. To allow the exhaust steam to escape uncondensed is, however, a disgrace to engineers. In all these types of surface condensers which act by transmission of heat provision should be carefully made for cleaning both sides of the small tubes at short intervals, as with dirty water and greasy steam thick coatings are very quickly formed. Both grease and dirt are bad conductors of heat.

Very hard water also produces a deposit of sulphate and carbonate of lime on the tubes. In the case of a factory or works having a large number of non condensing engines, one central surface condenser is sometimes used, and the various exhaust steam pipes led into it.

A special engine for driving the air pump, circulating water pump, and fan is necessary, but the only difficulty with this arrangement is to keep the joints tight. On ships the exhaust steam of the small auxiliary engines is now conducted into the main surface condenser, but a minimum quantity of oil must be used in the cylinder of small engines.

Another important application, now largely utilized in steamships, is to raise the temperature of the feed-water by the heat of the exhaust steam from the low-pressure cylinder. In locomotives the exhaust steam is now wholly relied on to create the induced draught, but more could be done with it. Here a large field awaits the inventor who can succeed in utilizing part of the heat of the exhaust steam to warm the feed-water without diminishing the draught. The method has been tried and partly adopted in France, with a fan for giving the induced draught. Of late years exhaust-steam injectors have been introduced to force the exhaust steam and feed-water together into the boiler, but care must be taken that it does not become greasy. The exhaust steam from the feed or donkey pumps of small engines should

be utilized, and the heat in them put into the boiler feed-water. Injectors, in which the steam goes into the feed-water, are much more economical than ordinary cheap feed-pumps, as the latter consume an enormous amount of steam—much more than either the seller or the buyer realize. Makers should guarantee the quantity required by their pumps to force so much water per hour into the boilers. Feed-pumps driven by gas, oil, or electricity are in the majority of cases much more economical.

In all the various mills and factories the exhaust steam from steam pipes, jacketed pans, and other steam-heated apparatus should all be drained back to the engine, and pumped into the boiler hot. Exhaust steam contains so much latent heat that the hot water obtained from it by condensation should be treated with great care, and utilized wherever possible, instead of being carelessly run to waste into the nearest drain, as if it were cold or dirty. Attention to these details in large factories results in a considerable economy of heat, and the expense incurred is generally covered in about a year. At the writer's works the hot water from the steam jackets of the engines, and from all the steam pipes used for heating the buildings, and all the water from the steam-supply pipes, is conducted to a large hot-water tank, whence it is pumped back into the boiler.

To sum up, exhaust steam contains a large quantity of latent heat. Heat is expensive. In these days of small profits it is absolutely necessary to save money, and not to waste it. Engineers, therefore, should look to their heat wastes in all directions, abolish them where possible, and thus save their money.

SHIP BUILDING AS A PRODUCTIVE INDUSTRY IN GREAT BRITAIN.

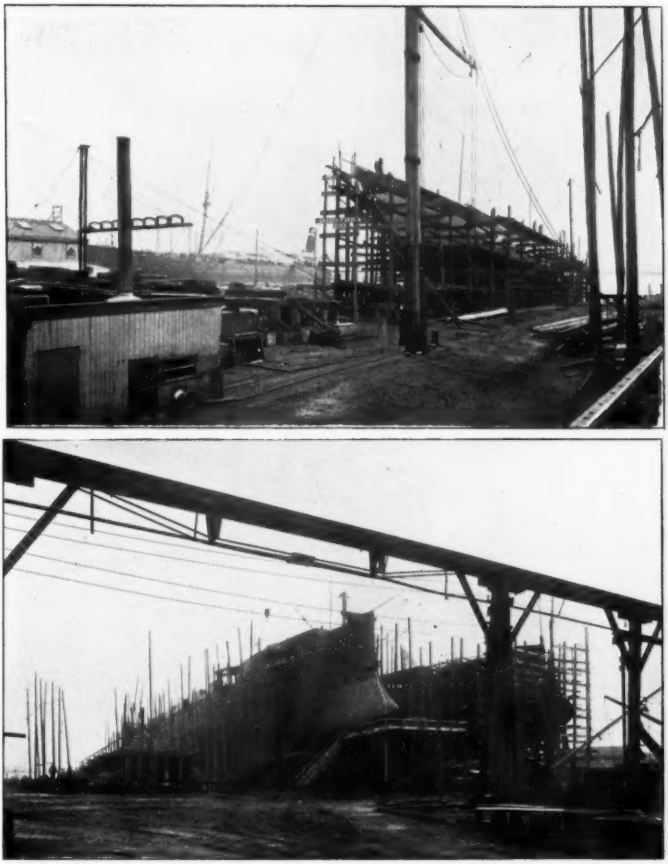
By James McKechnie.

IV.—RATIO OF OUTPUT TO WAGES THE DECIDING FACTOR IN THE RISING COMPETITION.

THE vessel-tonnage produced per annum in the United States is only about one-sixth of that produced in the United Kingdom; in Germany it is barely one-fifth, and in France much less. It is profitable to consider dispassionately not only the reason for this supremacy, but the prospects of future developments in other countries.

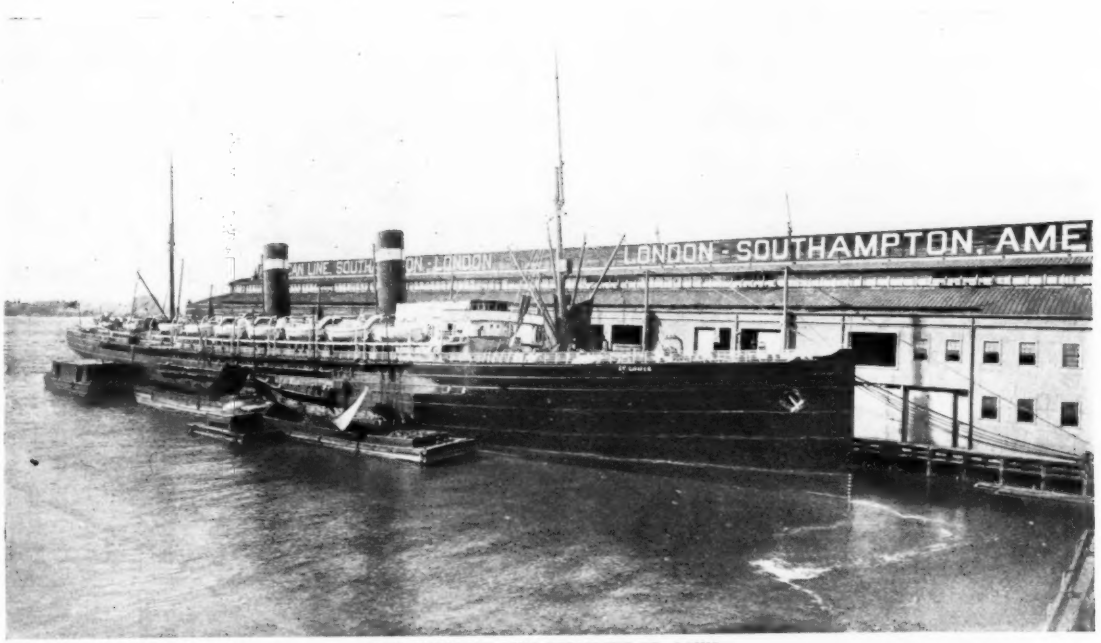
As I have said in a previous article, Britain's insular position made a fleet necessary, but early in the century the United States's wooden clippers, and France's vessels in a less degree, shared with her the shipping trade of the world. The possession of iron ore was not confined to England, but British builders more quickly recognised the possibilities of iron for construction and of steam for propulsion; and, more fortunately still, the declaration of a free-trade policy came to augment enormously the value of the artisan's wage at the right moment—at a time when discontent was in the bud. No attempt was made to reduce the rate or the sum of the wage,—it has all along been the other way—but the cheapening of the necessaries of life at once had its effect. Britain had a better fed, and therefore a more industrious, worker. The better qualities of man were quickened in direct proportion to his improved social conditions; the mind was developed, and work-problems were attacked with the greater courage. The value of labour was thus greatly enhanced, and there is no question that even to-day Britain's position among the nations continues to be due, amid increasing competition, to this higher average physical and mental status. The spirit of independence has been fostered; and, although it may from time to time assert itself in unfortunate ways, aspiration must always be in advance of attainment.

Another important factor is that England was "in" at the beginning. I can recall cases where owners pleaded with the builder to accept work at his own terms, the only stipulation being that the ship was to be hurried forward. Experience could thus be bought at the expense of the owner, who easily recouped himself, since competition had not yet tightened the purse-strings of the exporting agent. Now the ship builder of any country is no longer master of the situation,



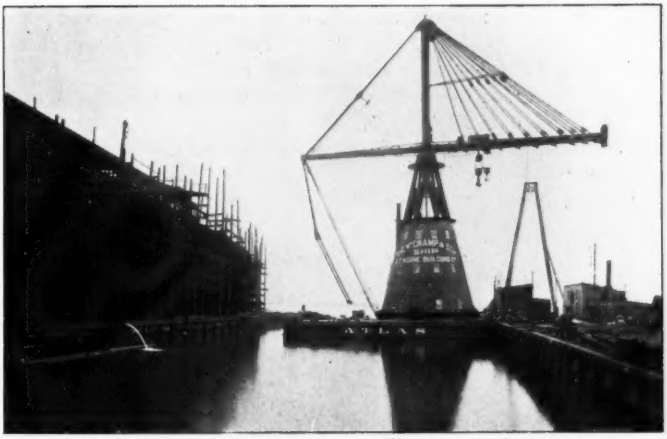
THE JAPANESE CRUISER "KASAGI" AND THE YACHT "DOROTHEA" ON THE STOCKS AT THE SHIP YARD OF THE WM. CRAMP & SONS SHIP AND ENGINE BUILDING CO., PHILADELPHIA, PA., U. S. A.

but must meet the most stringent conditions ; still, England has the advantage of experience. It is true, as with all science, that she has been prodigal with out-gifts,—the pages of her scientific publications bear testimony,—but there is much that cannot be transmitted through the printing-machine, nor can the place of experience be taken by scientific or theoretical training. A friend who has been in correspondence with Mr. Charles Cramp permits me to copy part of a



THE AMERICAN LINE STEAMSHIP ST. LOUIS.

Built by the Wm. Cramp & Sons Ship and Engine Building Co. 534x63x42 feet; 11,629 tons; 20,000 i. h. p.



THE FLOATING DERRICK-CRANE "ATLAS" AT CRAMPS' SHIPYARD.

letter, hitherto unpublished, which gives his views on this very question. Mr. Cramp writes:

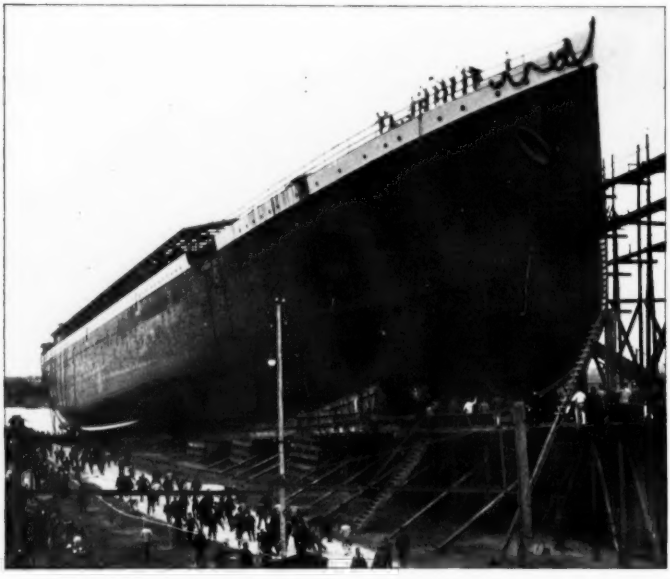
"The world—or, more particularly, the English-speaking world—is full of colleges, academies, institutes of technology, etc., engaged in educating young men to be 'scientific' naval architects, marine engineers, etc.

"These young men graduate early in their twenties, and are sup-

PART OF THE YARDS OF THE WM. CRAMP & SONS SHIP AND ENGINE BUILDING CO.
The bow of the U. S. S. "Alabama" is seen on the right.

posed—or suppose themselves—to be of thorough professional equipment. As a matter of fact, they are then hardly born—some of them but just conceived—in the professional sense ; but they are 'scientific,' they are masters of every formula, and perhaps, without ever having seen the inside of a shipyard or machine shop in actual operation, they at once begin to write 'professional papers,' and soon become known as 'authorities.'

"Thus, whenever any man of real equipment and actual experience



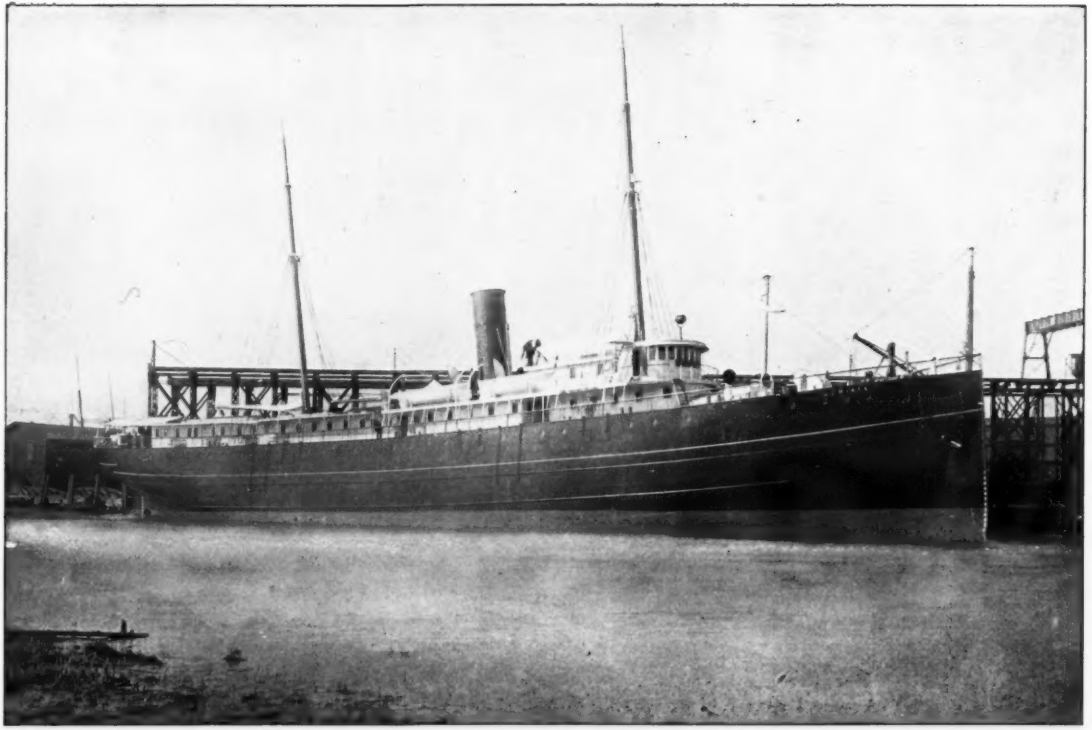
LAUNCH OF THE EXPRESS STEAMER "KAISER FRIEDRICH."

17,500 tons displacement; 28,000 i. h. p. Built by F. Schichau, Dantzig.

undertakes to write about ships and ship building, he is likely to be pounced upon by this brood, and the general public, not understanding a word that is said, and overawed by their facility in the use of obscure technical terms and by the profusion of their integral and differential calculus, will think they have the best of it.

"This is not encouraging."

Mr. Cramp also makes it clear that the design of the St. Paul and St. Louis was a process of evolution from earlier ships "the details of which would fill the shelves of a library. . . . I am frank to say



AN AMERICAN-BUILT COASTWISE STEAMSHIP, THE "JUNIATA."

Built by Harlan & Hollingsworth, Wilmington, Del., U. S. A. 270x42x26 feet; speed 15 knots. Run by the Merchants' & Miners' Transportation Co., between Baltimore and Boston.

that, while I am the head of these works, and while my name is currently associated with the planning and building of these ships, they are actually the products of numerous minds; their existence represents the essence, or the extract, so to speak, of many personalities." This is only characteristically magnanimous of Mr. Cramp, who has done so much for the industry in the United States: but it is incontrovertible that there must be a guiding head, equipped with experience to act as arbiter, receiving and encouraging the good and rejecting the bad. Therefore to Mr. Cramp is indeed due the success that has been attained in the two ships named, and that is traceable to his long association with ship building.

But there is always an inclination to overrate experience and the prestige it brings. The conservatism of contentment increases with years; the aged keep saying: "That which is is best," but happily there is, even in the old country, sufficient leaven of youth to keep the whole lump vigorous. The lesson which the impetuous activity of the United States is teaching in favour of labour-saving machinery of high productive capacity is slowly being realised in Europe. While wages in Britain have been lower, their purchasing value has been higher, but the ratio of product to wage has been less than in the United States. The advantage is undoubtedly with the British worker; but in the United States, whether or not the worker has equal value in wage, the employer has the advantage over the British employer in view of the higher production per pound sterling of wage.* These are points not often pondered over, and yet they are of the essence of practical economics. The real problem of the future is, therefore, whether Britain, with her satisfactory wage value, can increase her productive capacity. In European countries the wage is low, and long hours and use of the same machine tools make the product nearly as cheap as Britain's.

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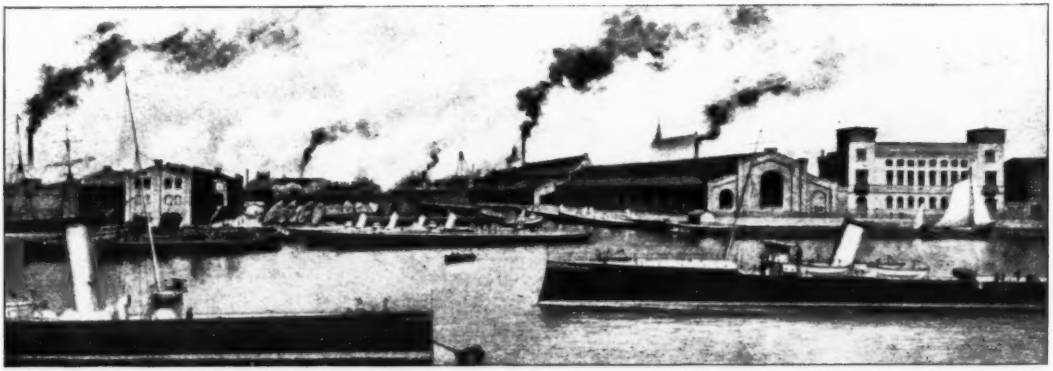
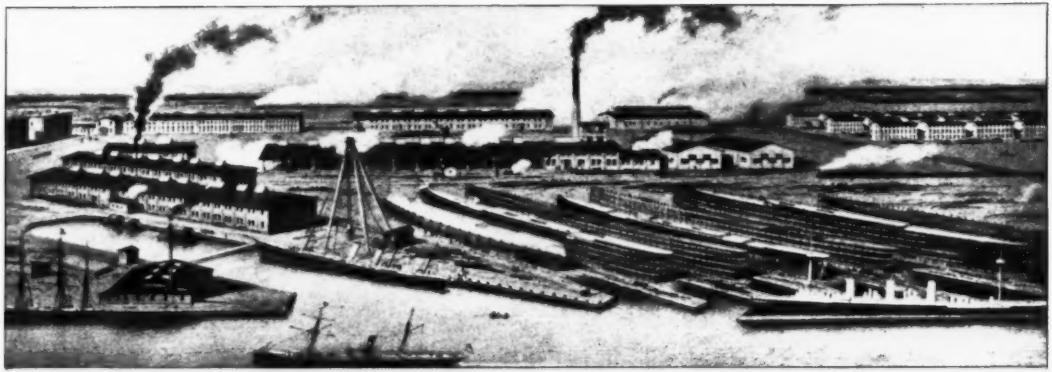
* The following figures have been deduced from the census returns by a correspondent in the Glasgow *Herald*.

	America in millions.	Britain in millions	Germany in millions.	France in millions.	Russia in millions.
Total value of a year's production.....	£1,440	£845	£600	£463	£375
The average wages per year of all industry	£72	£42	£32	£36	£25
Average value of each person's production.....	£388	£163	£112	£112	£78
Proportion of production value to wages.....	5·4	3·95	3·6	3·1	3·13
Difference between wages and production.....	£316	£121	£80	£76	£53

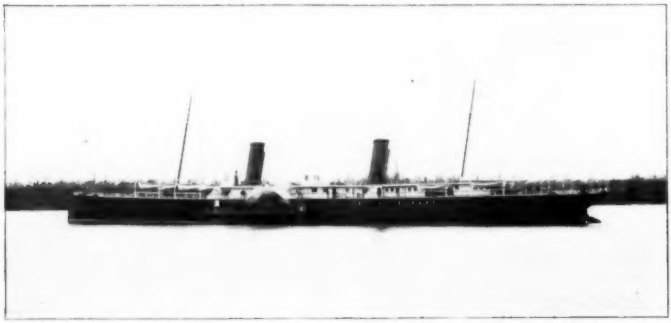


SHIP YARD OF F. SHICHAU AT ELBING, PRUSSIA.



F. SCHICHAU'S SHIP YARD FOR LARGER SHIPS AT DANZIG.

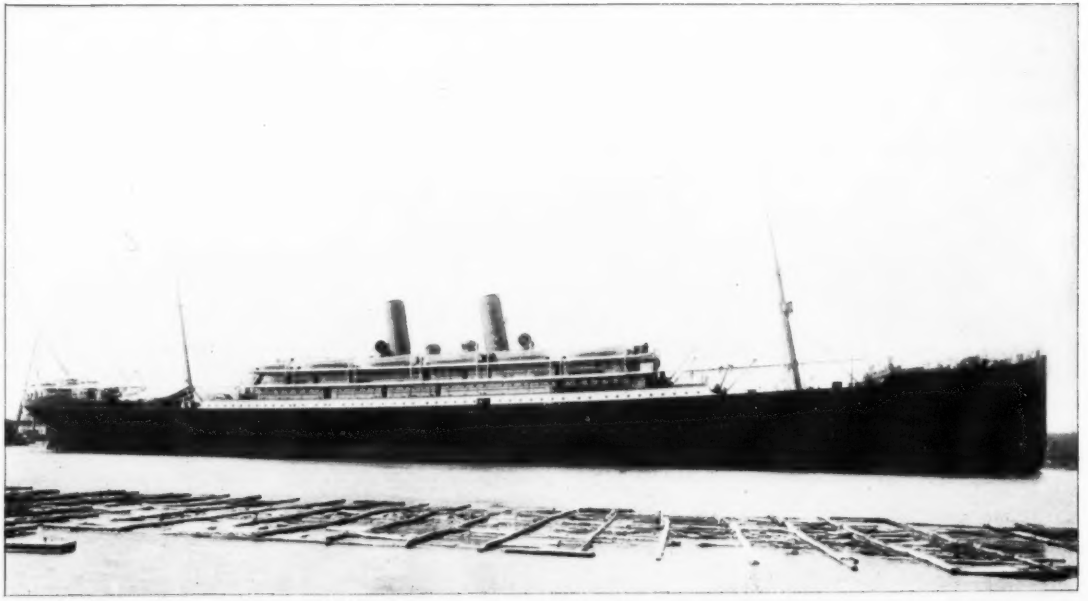
Some general suggestion of the relative gross wage-earnings in different countries is difficult to arrive at, especially in view of the variations in conditions, and I do not care to accept here any statement which has been prepared with a purpose. Mulhall, in one of his latest books, gives the gross earnings *per capita*, which are not without indirect interest, and he shows that in the United Kingdom they are nearly 20 per cent. less than in the United States, although nearly 33 per cent. greater than in some of the European countries—notably Germany. This is not by any means overstating the difference in wage; one experienced engineer from the United States lately put it that the wages paid on the Clyde were only 55 per cent. of those paid in United States marine-engineering shops; and in some of the continental centres the wage per hour is little more than half what it is in Britain. But the rate of the wage is no criterion of the



MAIL STEAMER "PRINCESSE CLEMENTINE," IN THE OSTEND-DOVER SERVICE.
Built by the Société Anonyme John Cockerill, Seraing, Belgium.

relative value, either to employer or worker. Food is cheaper in the United States; on an average, the worker there spends one-sixth of his earnings on food, whereas in Britain the worker spends one-fourth for that purpose, while in continental countries he can afford only one-third. As some one has said: "Bread and beer-swilling, and an occasional bit of sausage, cannot give strength sufficient to compete with you"; but the conditions are being rectified very rapidly. All the same, the British workman stands preëminent in this food question, for the statistician tells us that the Briton, on an average, consumes 110 pounds of meat, the German 75 pounds, the Frenchman 70 pounds, and the Belgian 56 pounds. Thus one can well understand that more work is done by the Briton; but whether the ratio is two to one, as is the rate of wage, is quite another matter.

But, while food is cheaper in the United States, other commodi-



NORTH-GERMAN-LLOYD STEAMSHIP "BREMEN."

525x60x38 feet; 8,000 tons displacement; 18,000 i. h. p; average service speed 14 knots. She has room for 2,300 passengers and 8,600 tons freight. Built by F. Schichau, Dantzig, 1896-7.

A PART OF THE SHIPYARD AND WORKS OF THE VULCAN COMPANY, STETTIN, PRUSSIA.

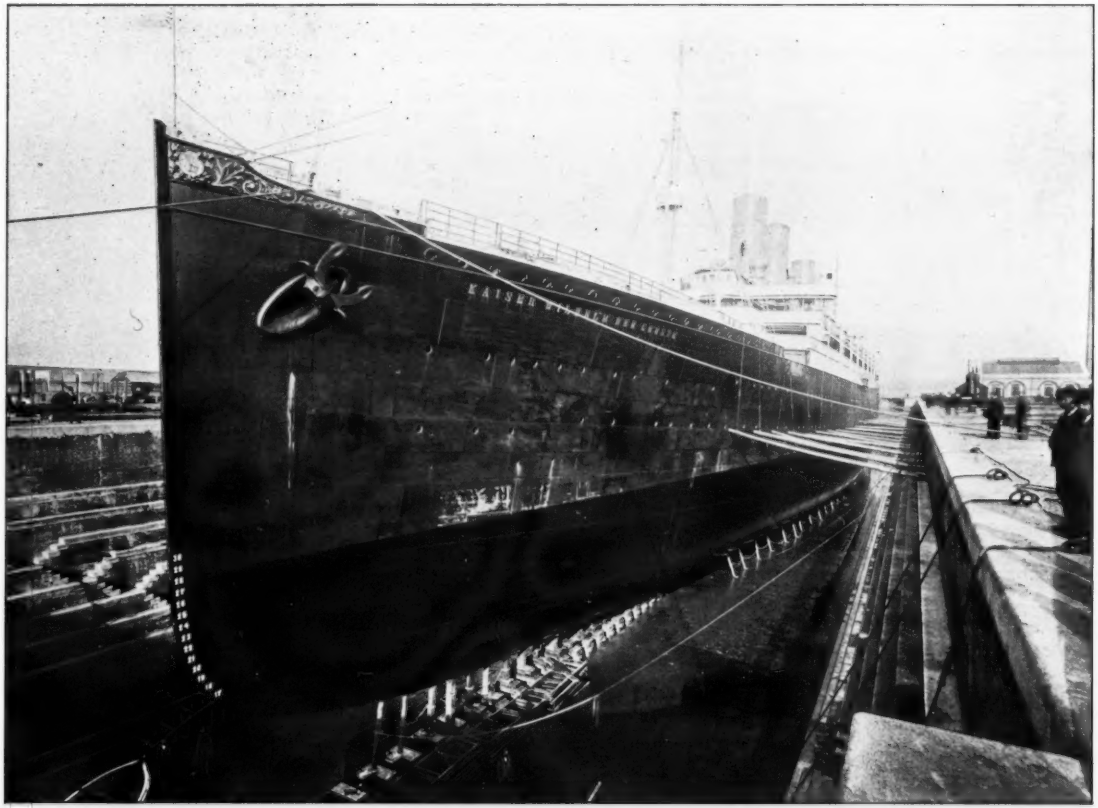
PART OF THE SHIPYARD AND WORKS OF THE VULCAN COMPANY, STETTIN, PRUSSIA.

This engraving, placed to the right of the one on the opposite page, forms a continuous panorama of the Vulcan Works.

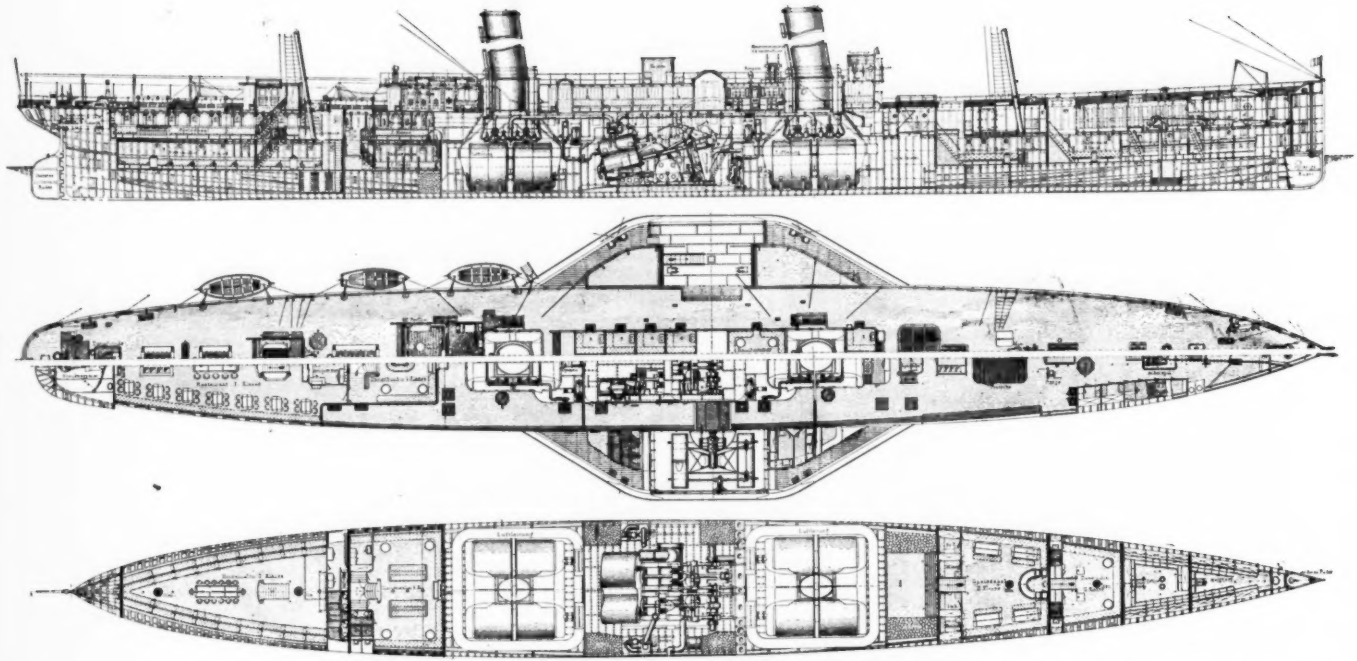
ties—wearing-apparel and the like—are dearer, and this largely by reason of the tariff. I do not purpose entering into the question of free trade against protection; a consideration of the direct influence on ship building is sufficient. It has been shown from official returns that only five or six per cent. of the workers in the United States profit by protection, and it stands to reason that all others are taxed to assist the industries in which these five or six per cent. are engaged. Thus if, as in a recent year, each inhabitant imports 50s. worth of goods each year, and pays 14s. of that sum in tariff rates, it means that £3 or £4 of the gross earnings of each head of a family of three or four go to support another industry. Thus, three-fourths of the price of some textile fabrics goes for tariff, and half of the price of cotton goods, while it may almost be said that the great metallurgical industries have no help; in fact, they no longer need it. The tax is indirect, but it is unequal in its incidence. No doubt some industries require fostering in the earlier stages; but since the civil war this help has been disproportionate to the need, and, as in 1816, an exhaustive inquiry is necessary to determine what industries are permanently established and have no need of protection, what industries are only partially established and might be fostered with help, and what industries help has failed to bring to a vigorous maturity. There is the story of the Senator grandfather who, inculcating economy, remarked that "it isn't what a man makes that makes him rich," and was met with the reply from the seven-year-old grandson: "Oh, no, it is getting a prohibitive tariff put on."

Of course, a relief in tariff rates would increase the value of wages, and so improve the condition of the worker, and therefore his work. The American ship builder may get his material more cheaply than his competitor in Britain, pig iron being 10 to 15 per cent., and steel nearly 20 per cent., less in the United States than in Britain. The equability of temperature in Britain and the cheap sea transport are in her favour: but a cheapening of clothing, if not of all other household effects, may nullify the former, and the railway freight from the mines is marvellously low. There is just the possibility, too, of a lower rate of wage, owing to the influx of workers and the immunity from trade-union interference; but these cannot be reckoned on with any certainty in favour of United States possibilities.

As to the need of assisting shipping, it is more difficult to write without being swayed by the success in Britain where no such help has been given. In the United States there are millions who have never seen the sea; they have no love for it. The enormous area of the country can satisfy any desire for migratory adventure; its varied climates, its gold fields, its prairies, its free life, generally provide



THE NORTH-GERMAN-LLOYD STEAMSHIP "KAISER WILHELM DER GROSSE," IN DRY DOCK.
Built by the Vulcan Company, Stettin, Prussia. 625x66x43 feet; 14,350 tons; 27,000 i. h. p.; speed, 22 knots.



THE BELGIAN MAIL STEAMER "MARIE HENRIETTE."

Built by the Société Anonyme John Cockerill, Seraing, Belgium. Length between perpendiculars, 340 ft.; breadth over paddle boxes, 76 ft. 7 in.; depth over the keel to main deck, 15 ft.; mean i. h. p. 8,000; mean speed on official trials, 22.2 knots.

change enough in pursuits, whereas "the sea is England's glory," in very truth. In England, to ship before the mast was, if it is not still, the ambition of every wayward youth; if he seeks the gold diggings, it is as an after-thought. Thus there is difficulty in awakening American interest and of finding American sailors, but there is no reason why the Scandinavian should not as readily sail under the Stars and Stripes as under the Union Jack. But there must be freedom of choice and of other conditions, as in Britain. The United States have trade for a fleet, but the financier lacks courage to enter heroically into the trade and give the builder sufficiently frequent orders to warrant experienced management and staffs, thus assuring as economical production as that which prevails in Britain. It is really more a question of removing disabilities than of providing subsidies for ordinary merchant steamers. Of course, I do not include mail contracts in the term "subsidy." The British owner has had to fight for economy, because he had no subsidy: the biggest lines—the British India, for instance—have not even the help of a mail contract, and in no country in Europe have subsidies created a general fleet comparable with that of Britain.

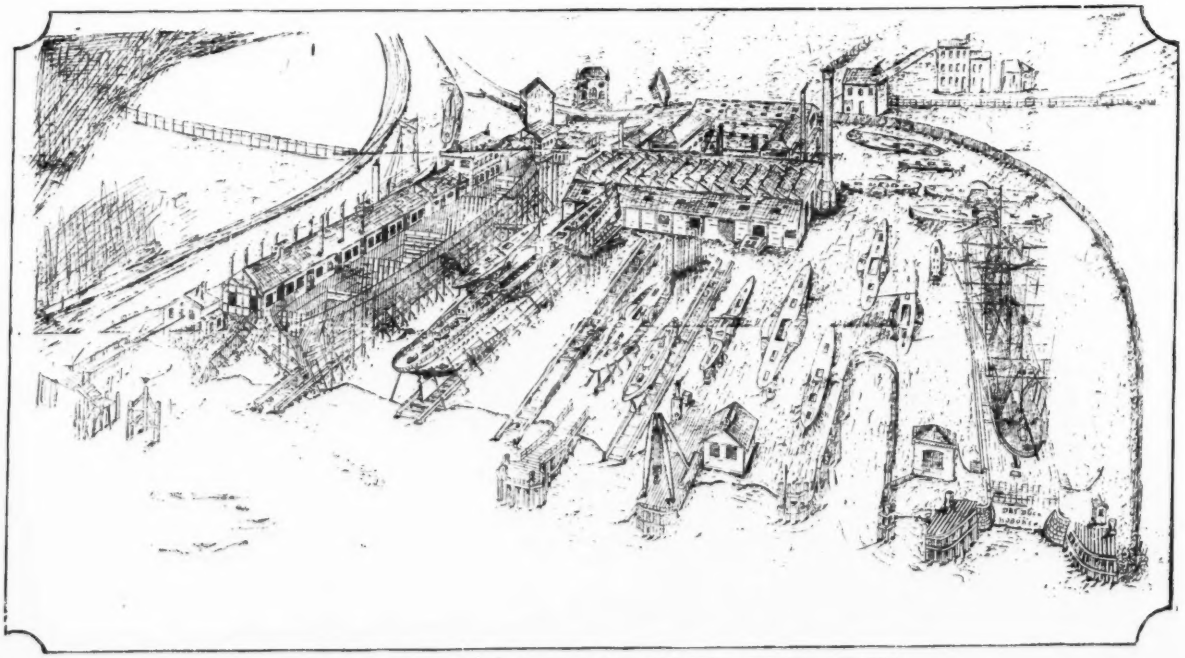
With the United States the task of the future is the more difficult (although not impossible), because it is largely creative; with Britain it is only the retention of a trade still flourishing courageously, but threatened on all sides. The question in Britain is whether, without materially increasing wages, she can secure such an assimilation of conditions as to give her the same producing capacity that the United States enjoy. On that will depend the future relative position of the two countries. The idiosyncracy of the worker is an important factor. In the United States, especially after the war, wages were kept at a high and artificial level. Workers were few at the inception of industries, and thus the reward of labour-saving appliances to the capitalist was encouraging. All ingenuity was diverted into this channel, especially in the case of small productions,—*i. e.*, sewing machines and the like,—in some cases at the expense of the development of mineral, metal, and heavier engineering industries. The early worker readily accepted the conditions. He saw no reason against working two or three machines for all they were worth, provided his wages were satisfactory; and even now that is the practice. Rightly so, too, for the purchasing power of wages rises with the increase in the productiveness of labour, provided prohibitive tariff does not vitiate economic conditions. The Ricardian theory of man being unable to wear four coats simply because they now cost only a fourth as much has long since been exploded by the circumstance that, if he wears only two, he can in other directions add to his com-

fort, and so disburse his wage and create still greater need for labour. Thus in the United States the employer has no difficulty in inducing the worker to produce the maximum. I have heard of cases where, if the worker augmented a given high rate of production, he would secure a *pro rata* addition to the standard rate of piece-work.

In Britain, on the other hand, everything was originally done by hand. The prospect of lack of employment obscured the vision of the worker, and even now, after the lapse of thirty years and more, he has not quite acquired the lesson that cheapened production decreases the selling price to such an extent as ultimately to increase the demand and the need for producers. Men refuse to do their best at piece-work, lest the rates be reduced or the unemployed list be increased, and thus the most is not made out of the plant. The employers, again, may introduce the most ingenious of tools,—many from America, for instance,—but in the British ship-building yard or engineering works, where many are installed, the work done is 20 to 30 per cent. less than with identical tools in the United States. Moreover, in some cases two such machines may be tended by one man in the United States,—perhaps only an unskilled labourer,—while the trade-union leader in England demands that each shall be attended by one experienced tradesman, and that the production shall be limited.

Under conditions like these, a comparison of mere rates of pay conveys inaccurate ideas, for the United States machinery attendant, for, a daily wage, say, 50 per cent. higher than that of the British mechanic, may produce 180 per cent. more work. It is but a high testimony to Britain's repute and to the practical experience of management and worker that she has so long maintained her supremacy. There must be a limit, and the difficulty is to determine when it is reached. The policy of improving the condition of the worker has been satisfactory in the past. In the savings bank there is now for each inhabitant fully four times what there was sixty years ago, while at the same time only 80 per cent. of the population live in houses rated at less than £20 a year; fifty years ago there were 93 per cent. so situated. As to education, 33 per cent. of the couples married sixty years ago could not sign the marriage certificate, whereas now barely 7 per cent. are so illiterate. As to the supersession of hand workers by machines, no more significant proof to the contrary can be found than the fact that, whereas ten years ago only 34.8 per cent. of the population were engaged in factories, now 53.7 per cent. are so employed.

Britain has marched forward in superiority by reason of the individual experience of her workers; but they are becoming scattered



SHIP YARD OF THE SOCIÉTÉ ANONYME JOHN COCKERILL, SERAING, BELGIUM.

over the world. I have heard Mr. Cramp say that many of his Scotch and English workers were driven from home by the unscrupulous exactions of trade unionism. It is not generally known that most of the unions accept members who pay a smaller contribution than the full-paying member, receiving in return nothing, or practically nothing, but the right to work, or freedom from what is now known as boycotting,—a system which, if applied by the masters, might be called by a very hard name. These exiles, so to speak, soon disseminate the principles of British workmanship, especially as they soon reach the status of leading hands. And in any case other countries are now experiencing the success of failure well analysed. Almost every country yields proof of attainment of this stage. France has built the channel twin-screw steamers Tamise and Seine, running between Newhaven and Dieppe with efficiency equal to that of the Clyde-built Sussex, and is now building high-speed paddle steamers for the Dover and Calais mail service with engines of 7,000 i. h. p., to give 21½ knots speed in order to beat Clyde boats running there. Belgium has built the Marie Henriette and the Rapide, 22-knot paddle steamers running between Dover and Ostend as regularly as do the British ships Princesse Henrietta and Leopold II. Holland seeks to exert her influence on the Queenborough and Flushing route, and Germany has shown her skill with Atlantic, Australian, and China traders, and has produced the Kaiser Wilhelm der Grosse, the fastest ship in the Atlantic service, for which service Germany has twelve large steamers in process of construction. The United States have shown their skill in the St. Paul and St. Louis, so that it is too late in the day to think that British supremacy is unassailable. British merchantmen have led the way in speed and other sea-going qualities, though the navy has been quickly brought into line. In all other countries the navy has assisted materially in the education of the artisan.

The worker, when disputes arise, is too apt to impute selfishness to the employer. I have tried to show, rather, that the fate of a great national industry is in the balance. One thing seems clear; Britain cannot afford to increase the cost of production, since other countries are overtaking her in excellence and economy. A reduction in the hours of labour or in the rate of wage must be compensated for by an increased rate of production. There is no alternative, except it be the contemplation of the saying: "Times change, and we change with them."

THE CONSTRUCTION OF SLOW-BURNING BUILDINGS.

By Francis C. Moore.

FIRE protection, or fire-proof construction, so far as it relates to warehouse or office-buildings, has been the subject of much study and experiment, and the center of active discussion and thought. It is, therefore, rather strange that comparatively little attention appears to have been directed to the extension of the same principles to the buildings which, in the end, touch us all more closely. It is safe to say that to the average reputable citizen no place is so constantly the object of his thought and care as his home. It is the shelter of his family, and is the spot in which he himself finds comfort and rest. In earlier days he was obliged to barricade it against human enemies, while to-day he needs to protect it only against rain, snow, wind, and fire. The latter is his most dangerous enemy. It is liable to attack him in any one of the twenty-four hours, but most liable to turn him out of house and home in the middle of the night and in the middle of the winter, when the weather is coldest and when he is unconscious in sleep. He may well be thankful to any who will give him a hint as to how to ward off danger, and it is doubtful if he can look for valuable suggestions to any of his fellow-citizens with such assurance as to those who are engaged as underwriters in insuring against loss by fire, or as firemen in extinguishing fires, and who have, by reason of their callings, the largest experience, and, therefore, the greatest knowledge, as to how to construct dwellings with a minimum of fire hazard.

It is possible, of course, by the exclusive use of iron and brick, to construct a dwelling so that its owner may sleep complacently, without anxiety as to fire; but such construction is expensive, and there are few fire-proof houses outside of the largest and wealthiest cities. The majority of dwelling-houses in the United States, by reason of the relative cheapness of lumber as compared with masonry, are of wood. Probably the dwellings of Europe are built so largely of masonry because wood is expensive, and safer construction is an economic necessity. "For lack of wood the fire goeth out," but sometimes, even in Europe, not before it has wrought immense damage. While this article, therefore, is addressed especially to American practice, the principles and methods advanced are applicable on both sides of the Atlantic. If the writer, therefore, claims—and he does so claim—that it is possible to construct a dwelling-house of wood

throughout in the most economical manner, and yet by such methods as will probably prevent its taking fire, or, in case of ignition, will so retard the progress of the flames as to admit of the escape of the inmates, if not, indeed, of the extinction of the fire without their being driven out of the building, he ought to find willing readers.

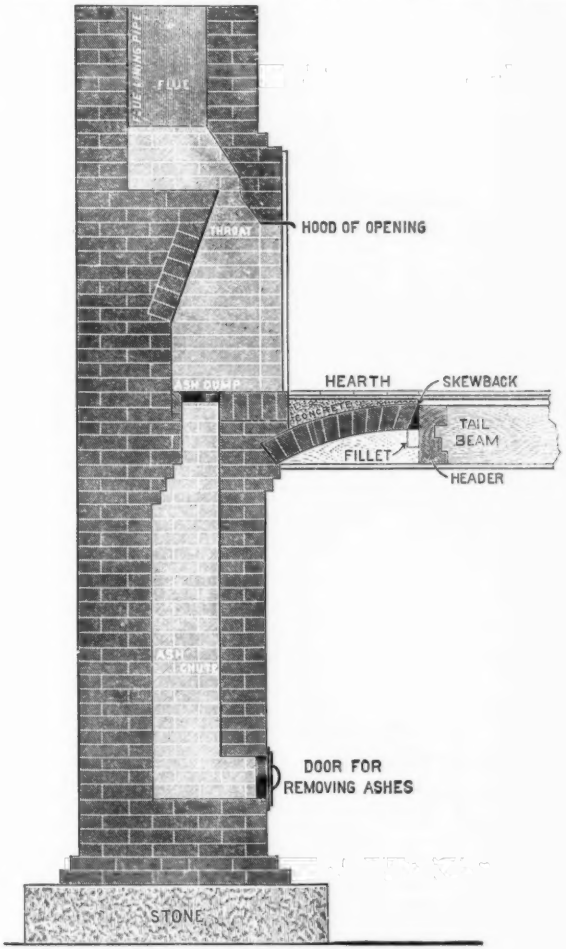
PREVENTION OF FIRES.

Flues. In nothing is the adage "an ounce of prevention is worth a pound of cure" more true than in dealing with fire. Fortunately the precautions necessary to prevent fires are inexpensive, and quite within the means of any one who builds a home, for he can make his dwelling secure for less than he usually expends in unnecessary ornamentation. The main thing to be observed is the proper construction of chimneys, fireplaces, furnaces, etc. Probably eighty per cent. of the flues in dwellings throughout the United States are unsafe, being only four inches, or half a brick, thick. Where the walls surrounding a smoke flue are less than eight inches thick, they should be lined with burned-clay flue lining. Ordinary, well-burned drain pipe makes good flue linings, although it is best to use linings manufactured especially for the purpose. I advise lining all flues, however,—even those having eight inches of enclosing brickwork. Where the chimney comes next to the weather, the eight inches will be worth all it costs in improving the draft of the flue, which would otherwise be chilled and result in a smoking fireplace. The flue lining, also, improves the draft, and—what is more important—insures something that cannot always be counted upon at the hands of masons—a flue for the full uniform size stipulated in the specifications.

No floor timbers or other woodwork should come within eight inches of the inside of any smoke flue, or within two inches of the outside of such flue. It is, however, customary for carpenters, in fastening their work, to drive wooden plugs, or wedges, into the joints of the brickwork. Where the enclosing wall is only four inches in thickness, there can be but one result. The statistics of fires show that more than twenty per cent. of those occurring in the United States each year are due to defective flues. This means a loss of more than twenty millions of dollars annually, and an inexcusable drain upon the prosperity of the country; for, although insurance companies pay a large percentage of the property loss, they must, in turn, recoup themselves by higher rates of premium collected from property owners, so it is equally a loss to the country.

Hearths. All hearths to fireplaces should be supported by what are called "trimmer arches" of brick, illustrated in the accompanying diagram.

These arches rest at one end on the brickwork of the chimney, the other abutment being on what is known as a "header" beam



SECTION OF A PROPERLY BUILT HEARTH AND CHIMNEY.

(also shown in the illustration), so that the hearth does not in any case rest upon wooden beams. This simple, but important, precaution is frequently neglected, and the most reprehensible carelessness

amounting to criminal indifference to the safety of human life, is to be observed in many of our most expensive dwelling-houses. In one case coming to my notice, after the extinguishing of a fire in a costly dwelling, it was found that not only did the hearth of a fireplace rest upon the wooden floor beams, which had been carried under it, but the builder had actually swept the shavings and wooden rubbish into the space beneath the hearth, before laying the tile.

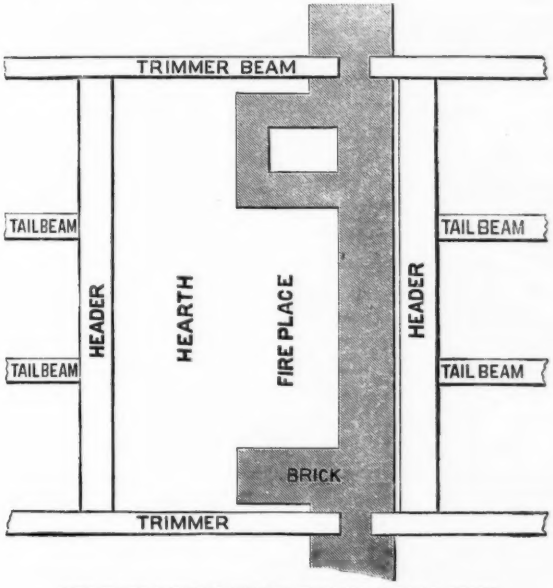
While on the subject of hearths and flues, it may be well to note that the illustration shows what a chimney should be, and to say that the shape of the fireplace, the inclination forward of the brickwork of the back, the contraction of the throat, and the square shelf observed in the drawing are all necessary to insure a good draft and to prevent that most disagreeable feature of a home—a "smoky" chimney.

It will be observed that an ash dump has been provided, and an ash chute. This costs nothing, and a person building can just as well secure it without extra expense, the bricks saved more than offsetting the labor of arranging the chute.

All chimneys should be built from the ground. Under no circumstances should they rest, as they frequently do, upon floor beams; and the framework of the building should be trimmed clear of them, so as to allow them to settle without opening cracks or joints. Especially is this precaution necessary where the chimney passes through the roof. At this point it is sometimes customary to enlarge the chimney so as to form an overhang or projection. The shoulder so formed is almost certain to cause a fracture in the chimney at the most dangerous of all points, in consequence of the brickwork settling faster than the woodwork of the dwelling.

All floor-timbers should be "trimmed" clear of the hearths and brickwork of the chimney, so as not to be in contact with it at any point. This is easily secured by what are known as "header"-beams, carried in front of the fireplace and at least twenty inches from the chimney-breast, supported by the "trimmer"-beams, which enter the wall on each side of the chimney. These should be at least four inches from the side of the chimney. The intervening "tail"-beams, as they are called, are mortised into the header. Where more than three tail-beams are framed into the header, however, it should be supported in "stirrup"-irons (sometimes called "bridle"-irons), by which the weight is carried on the trimmer-beams without mortising into them by "tenon-and-tusk" joints, which sacrifice material and carrying-capacity. In this way the floor-beams are free of contact with chimney-flues. The building law of New York city requires (what should not in any case be neglected) that all hearths shall be laid on trimmer-arches of

brick carried across from the chimney-breast to the header-beam already described, so that the hearth shall not rest upon or near wooden beams in any case. This whole matter is more fully explained by the accompanying illustrations:



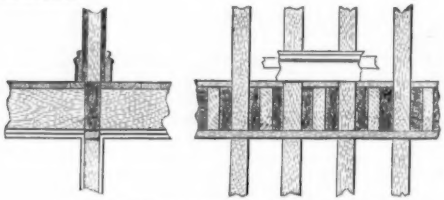
FIRE PLACE SHOWING HEADER, TRIMMER AND TAIL BEAMS.

Furnaces. These are fruitful sources of fires. They are generally provided with wooden cold-air boxes. The result is that a back draft from the furnace will cause a fire; also, dried leaves or other rubbish blown in from the outside are apt to ignite. Metal cold-air boxes should in all cases be provided. They cost more money, but they insure the house, as well as the health of the inmates. Wooden boxes open joints or seasoning cracks, and take the dangerous air of the cellar from wet coal, decaying vegetables, etc., sending it throughout the living rooms of the house, whereas a galvanized-iron cold-air box insures pure air from the outside. In this respect alone air-tight metal cold-air boxes are worth many times their extra cost.

Furnace Hot-Air Flues. These, where they pass between floors or wooden partitions, should be double, with an inner and outer pipe, separated by an air-space of, say, half an inch. It is well to stipulate, also, that the wooden studs in partitions shall be covered

with bright tin, and an additional precaution, and one which will insure safety, is to fill the space in the partition around the pipe with gauged mortar,—that is, mortar mixed with plaster of Paris to insure hardness. Wooden lathings should not be used across the joists between which hot-air flues pass; in all cases metal lathing should be employed.

Fire-Stops in Hollow Partitions, etc. Having considered precautions which tend to prevent fires from starting, it is next in importance to prevent them from spreading. Unfortunately most American structures are built upon plans which seem to insure the rapid progress of flame from the starting-point to the roof. The enclosing walls of frame buildings, and all of the partitions which divide the rooms and hallways, are hollow; between every pair of studs, or joists, is a flue with a wooden lining of lath and plaster, in which fire secures an easy passage. It is very easy to correct this fault, it being necessary only to fill in at each floor all spaces which lead to the floors above with incombustible material, to stop a draft. Probably the best material is bricks and mortar, filled in to a height of about a foot, although mineral wool and other like substances may be employed. Even a few shovelfuls of mortar would, under ordinary circumstances, be sufficient. The accompanying illustration shows how this may be done. It is possible in this way to insure such slowness of burning as will enable the inmates to escape with their lives or, better still, to extinguish the fire itself and save the structure with its contents.



FIRE STOPS IN FLOORS AND PARTITIONS.

Probably not two per cent. of the dwellings of the United States have been erected with regard to this simple, but inexpensive, precaution. That thousands of lives are not lost annually is due to the fact that fires seldom start in dwelling-houses, rather than to proper precautions in construction. Even as it is, the mortality list is serious, and sufficiently large to justify the most stringent laws as to the construction of dwellings and careful official inspection of them while in process.

Buildings the enclosing walls of which are of brick or stone are usually furred off for plastering,—that is, wooden strips are nailed against the wall, to which the plastering laths are in turn nailed, to receive the plaster. This leaves an air-space of about an inch and a

half, through which flame finds ready progress to the upper levels of the building, working insidiously where it cannot be seen. The New York building law requires that in all furred walls the course of brick above the underside and below the top of each tier of floor beams shall project the thickness of the furring, to more effectually prevent the spread of fire,—a most important and inexpensive precaution.

The following specifications would provide, in any contract for building, the various precautions I have suggested :

SPECIFICATIONS.

Chimneys and Flues. The chimneys shall be carried up, as per drawings, from the ground. Above the roof black cement mortar shall be used, and all smoke flues shall be surrounded with eight inches of good brickwork, and shall be lined on the inside with a burned clay or terra-cotta flue-lining, from the bottom of the flue or from the throat of each fireplace continuously to the extreme height of the flue. The ends of such lining-pipe shall be made to fit close together, and the pipe shall be built in as the flue or flues are carried up. All flues for fireplaces shall be of a capacity 8″ × 12″, and the furnace- and range-flues shall also be 8″ × 12″ inside capacity. (NOTE.—If 8″ × 8″ flues be desired, so specify.)

All flues which are not lined shall have struck joints; no parging or plastering will be allowed on the inside of any flue.

Fireplaces. Here limit height of fireplace—I advise 25 inches. The back of all fireplaces shall be inclined toward the front, beginning six courses of brick from the floor of the hearth, as per drawings (see diagram), to secure a good draft, and the fireplaces shall be lined with firebrick, laid with close rubbed joints (or with cast-iron fireplace-lining, as per design and pattern specified, if cast-iron is preferred). The front opening of all fireplaces shall be supported by two iron bars ½″ × 2″, nine inches longer than the width of the opening, and shall be fitted with automatic ash dump grate. This to be furnished by mantel-man.

Furnish and set proper iron thimble in furnace-flue.

The tops of all chimneys shall be laid in black cement mortar, and shall be capped with a 3-inch capstone, and the openings in the capstone shall correspond in size with the dimension of each flue, so that no shoulder or other projection will extend over the opening.

No chimney shall be enlarged where it passes the roof to form any overhang or projection over the roof.

The chimney walls from the cellar to first floor shall be carried up to form ash pits, securely inclosed with brickwork, these to have 12″ × 16″ iron doors, with frame, in cellar, to be built in during construction. This contractor to furnish said iron doors and ash dump.

No chimney shall be started or built upon any floor or beam of wood, and in no case shall a chimney be corbeled out more than eight inches from the wall, and in all such cases the corbeling shall consist of at least five courses of brick.

All hearths shall be constructed with trimmer-arches extending twenty inches from the chimney-breast to a "skew back," or wedge-shaped piece of wood spiked to the header-beam, and the top of the arch is to be filled with two inches of concrete to the top of finish floor.

The header-beam shall rest securely in stirrup-irons to be furnished by carpenter, and there shall be no wooden lath or furring on the chimney-breast.

It will be observed, in the illustration on page 957, that the trimmer-arch abuts upon a wooden skew back, or wedge of wood securely spiked to the header-beam. The skew back is, in turn, supported by a fillet of wood spiked to the beam. This is necessary to secure a proper arch. If the footing of the arch comes squarely against the wooden header-beam, the shrinkage of the latter will in time release the arch, and allow it to fall. It is unfortunately, however, the practice not only to omit this skew back, but to omit the trimmer-arch altogether, and to support the hearth directly upon the floor-joists. This is a most dangerous construction, and a fire is only a question of time. It seems incomprehensible that an honest builder having any decent regard for safety to life would build in this way; yet fires from this cause are frequent.

FURNACE HOT-AIR PIPES, ETC.

All hot-air pipes shall be provided with a damper or valve at the furnace, and shall be of the sizes specified. The principal register shall be fastened open, so that it cannot be closed. The heating-pipes throughout the house to the various registers are to be constructed of the best (one cross) tin, and, wherever they pass between floors or other hollow partions, are to be made double, with an air space of ½ inch between the inner and outer pipe. The wood studs nearest the pipe shall be lined with bright tin with air-space. The lathing from stud to stud on both sides between which the pipes pass is to be of metal, and no hot-air pipe shall be nearer than three inches to any wooden studs; and this contractor shall notify the carpenter as to studs between which hot-air pipes are to pass, to secure requisite separation. This contractor is to furnish said metal lathing and attach the same; and any hot-air pipe entering a wooden partition, or passing between a wooden floor and the ceiling below, within ten feet of the furnace shall be made double, and shall be wrapped with ¼-inch asbestos board to a point fifteen feet distant from such furnace.

This contractor is also to furnish a cold-air box of 24 B B gage, galvanized iron of the best workmanship, double-seamed and well braced, fitted with regulating damper so secured that the cold air cannot be cut off by negligence or otherwise, the outer opening to be protected with wire netting; and the inlet for cold air shall be so arranged as to supply an adequate amount of air to the hot-air chamber of the furnace, and shall be at the top of the furnace between the cover of the hot-air chamber and the cover of the furnace, in order to prevent the overheating of the furnace cover near the ceiling or woodwork.

This contractor is to furnish also a metal shield of galvanized iron one inch larger in diameter than the top of the furnace, and suspend the same from the ceiling above the furnace so as to leave an air-space between the shield and the ceiling.

FIRE–STOPS.

Beam-filling. This contractor shall beam-fill all exterior walls between the beams with bricks laid in lime mortar to their top level, same thickness as wall.

Fire stops. This contractor shall provide fire-stops at each story in all hollow walls and hollow partitions. He shall fill in solid between all upright studs or timbers to the depth of the floor-beams with suitable incombustible materials, using, wherever possible, bricks and lime mortar for the purpose. Where it is impossible for any reason to use bricks and mortar, he shall use sheet tin, which shall be carefully and closely nailed to prevent the passage of flame.

In all furred brick walls the course of brick above the under side and below the top of each tier of floor-beams shall project the thickness of the furring, to more effectually prevent the spread of fire.

BRITISH RAILWAY FARES AND THEIR INFLUENCE ON TRAFFIC.

By William J. Stevens.

IN making any comparison of British and American railroad fares two important points must be kept steadily in view. The first is that the average journey in Great Britain is perforce much shorter than in America, and that the restrictions naturally imposed on the length of the journey by the geography of the country are enhanced by the enormous local traffic built up around the large towns, and more particularly in and around London. This traffic has grown enormously, and, whereas in America it is to a large extent catered for by the street-railroad companies, in the large towns of England the major part of it finds its way to the railways. That important class of traffic we will consider more in detail later, passing on to the second vital point of difference between the fares of the two countries, which arises from the fact that, whereas in Great Britain the uniform demand is for safety, speed, comfort, and seclusion on the comparatively short journeys undertaken, in America, while the standards of safety, comfort, and speed show greater variation, the demand for seclusion is practically non-existent. Hence the classes, as we have them in Great Britain, have no counterpart in America.

The average length of the journey on the railways in Great Britain may be estimated at about 9 miles. No official data on this subject are available, but for the year 1896 the average sum received per passenger of all classes, excepting season ticket holders, was 7.34 pence. This figure is diminishing, as a comparison with the average receipt per passenger ten years ago will show. This comparison is afforded below:

1887.	
Total receipts (excluding season and periodical tickets).....	£24,163,355
Number of passengers " " "	733,678,531
Average receipt per passenger.....	7.89 pence.
1896.	
Total receipts (excluding season and periodical tickets).....	£29,971,578
Number of passengers, " " "	980,339,433
Average receipt per passenger.....	7.34 pence.

From 1887 to 1896 the decline in the average amount of revenue per passenger was .55 of a penny, which, for the 980,000,000 carried in 1896, represents £2,246,611. This decline may be, and probably is, partly attributable to a shortening of the average distance

travelled, but it is also due to a considerable extent to declining fares. British railways do not, unfortunately, supply the figures necessary to test this accurately, for they do not give the number of passengers carried one mile, just as in the case of freight traffic they do not indicate the ton-mileage.

In the United States the average receipt per passenger per mile and the average amount paid per passenger, according to "Poor's Railroad Manual," have been as follows from 1884 to 1896 inclusive:

Year.	Average receipt per passenger per mile. Cents.	Average receipt per pas'ger Cents.
1884	2.356	61.87
1885	2.199	57.16
1886	2.194	55.43
1887	2.276	56.17
1888	2.246	55.68
1889	2.169	52.44
1890	2.174	52.13
1891	2.184	52.30
1892	2.168	50.99
1893	2.072	52.00
1894	2.025	48.34
1895	2.069	49.25
1896	2.034	49.58

During recent years the average rate per mile has certainly diminished very much, according to the above figures, but the fact that from 1872 to 1896 rate-cutting was very prevalent in the United States probably accounts for this, to some extent at least. Anyway, the average charge per passenger is distinctly more than 2 cents per mile. The average distance travelled per passenger is given by the same authority as follows:

Year.	Average distance travelled per passenger. Miles.	Year.	Average distance travelled per passenger. Miles.
1884	26.24	1889	24.18
1885	25.99	1890	24.05
1886	25.27	1891	23.95
1887	24.68	1892	23.59
1888	24.79	1896	24.38

The average distance travelled is thus about 24½ miles, as compared with 9 miles in Great Britain.

As regards the average charge per mile, there does not appear to be much to choose between American and British railways. In Great

Britain the fares are regulated to a large extent by the law, but the companies, in their own interests, go far beyond the obligations thus imposed upon them in their concessions to the public. In fact, even during the last ten years the policy of cheap fares has found many recruits among the managers of British railways, the tendency thereto having received much encouragement from the successful results of lines which had already boldly launched forth in that direction. The result has been an enormous development of the third-class traffic, representing the lowest scale of fares. This is the outcome of the extended facilities given to that class. Originally the first- and second class passengers secured, in return for their higher fares, not only a better class of carriage, but the right to travel by express trains. But now the ordinary third-class passenger enjoys the right of travelling by all trains, the exceptions to this being practically confined to a few trains to Brighton. In addition, the difference in the accommodation afforded to the three classes has lessened considerably, and in the process the third-class passenger has secured the largest benefits. In fact, the results of this encouragement of third-class traffic have been so successful as to seriously jeopardize the intermediate class, so that, while many companies, anticipating events, have already abolished it, others have largely reduced the second-class fares, in order to stimulate this traffic. In Scotland second-class is now non-existent, and in the case of several leading English lines (including the Great Eastern, Great Northern, and North Eastern), it is retained only for suburban traffic. In Ireland it flourishes, probably because the third-class accommodation there is, as a rule, much below the standard attained in other parts of the United Kingdom. The diversion of passenger traffic from the first and second classes to the third class may clearly be seen from the following comparison of the receipts for the United Kingdom from each class for the years 1887 and 1896:

	1887.		1896.	
Class.	Amount.	Per cent.	Amount.	Per cent.
First.....	£3,081,508	12.8	£3,133,149	10.5
Second.....	2,788,803	11.5	2,058,139	6.9
Third.....	18,293,044	75.7	24,780,290	82.6
Total.....	26,163,355	100.0	29,971,578	100.0

It will be observed that the third class traffic, even in the past ten years, has increased from 75 7 to 82.6 per cent. of the total passenger revenue. In fact, the whole of the increase in passenger receipts during the ten years has been in the third class, while, in addition, about £680,000 has been diverted from the superior classes to that

denomination. In the second class the decline was preëminently large, and, in fact, would have been much larger but for the stimulus given by a number of companies to this traffic during 1896 by a large reduction in the second-class fares. In 1896 there was an increase of £123,000 over the 1896 figure in the amount received from second class—the first increase shown for many years. In the number of passengers the third class shows an even larger predominance than in receipts. In 1896 this class represented 888,500,000 passengers out of a total of 980,500,000—equal to 91 per cent.

There is no doubt whatever that the bulk of the third-class fares are under one penny a mile. In the first place, the companies are compelled to provide sufficient accommodation at fares not exceeding one penny per mile, and also proper and sufficient workmen's trains "at such fares as appear to the board of trade to be reasonable." In the second place, fares more than a penny per mile are subject to passenger duty of 2 per cent. for urban traffic, and 5 per cent. for other traffic. As early as 1872, however, a parliamentary committee of both houses reported as follows as to the expediency of special legislation encouraging third class traffic :

"The history of the traffic in third-class passengers affords a strong argument against attempting to foresee and provide for a want of this description by imposing general, permanent, and compulsory obligations on railway companies. It has been shown that parliament, anxious to protect the lower classes at any rate from the apprehended monopoly of railway companies, imposed special obligations on the companies, supposed to be in favour of these classes, and attached to these obligations a special exemption from railway taxation. It has also been shown that *railway companies, in their own interest, are now doing for third-class passengers more than parliament ever thought of requiring;* that third-class traffic is one of the *most growing sources of profit;* and that the present operation of the special legislation on the subject is to give a very questionable exemption from general railway taxation, to create confusion and litigation, and to give the companies inducements for withholding from third-class passengers facilities which they would otherwise afford." The above remarks, written in 1872, are infinitely more applicable in 1898,—twenty-six years after,—though the passenger traffic now is nearly 150 per cent. greater than it was then, so far as the number carried is concerned. Examples of concessions made by the companies to the public over and above their parliamentary obligations are easy to find. The reductions on return tickets (which are often much cheaper than two single tickets) ; half-price charged for children; and no charge at all for infants,—are cases in point, for in none of the instances quoted are the companies

legally bound to afford the privileges they do. Further, in complying with the legislative requirement as to workmen's trains, they have gone much beyond expectation, and in other matters have conceded privileges which they are not required to grant. As evidence that the fares less than a penny per mile are increasing, and that those more than that are diminishing, the amounts paid by the companies as government duty may be given. For the last ten years the amounts thus paid have been as follows:

Financial year of government ended March 31.	Amount of Railway Passenger Duty. £
1888	314,993
1889	311,506
1890	324,461
1891	324,117
1892	324,984
1893	310,325
1894	279,093
1895	260,694
1896	259,342
1897	272,183

It should be pointed out that the above figures include government duty paid on season tickets, a class of revenue which has been showing great expansion in the last ten years. Though the fares for the daily journey with these tickets are generally less than the ordinary third-class return fare, and well under the limit of a penny per mile, the government duty charged depends upon whether the ordinary single fare of *the same class* is or is not more than a penny per mile. As most of the season tickets are for the first and second classes (some companies making a rule to issue none for the third class), most of the revenue from this source is chargeable with duty, and the duty so paid is included in the above figures. For 1896–7 the duty paid under the 2-per-cent. scale for urban traffic was £31,647—equal to a gross amount of £1,582,350. For the same period the amount received under the 5-per cent. scale for other traffic was £240,500—equal to a gross amount of traffic chargeable of £4,810,000. Thus the total traffic (including that derived from season tickets) charged with duty was about £6,392,000. Of this sum £2,914,000 was the amount of receipts from season tickets, etc., and, allowing therefor, it is probable that the amount received by the railways in respect of fares more than a penny per mile was not more than £4,000,000 out of nearly £30,000,000 in all. During the ten years, in spite of the fact that season-ticket revenue has increased by nearly a million (or 50 per

cent.), the amount of government duty paid has declined from £315,000 to £272,183, or nearly 14 per cent.

It would be unfair to judge English railways merely by the ordinary fares charged, for the concessions made in various directions are so important, and the traffic arising therefrom so large, that they cannot be omitted. Below is a brief summary of special tickets issued at reduced fares, ranging from less than a farthing to rather more than a penny per mile: tourists' tickets, excursion tickets, workmen's tickets, market tickets, week-end tickets, emigrants' tickets, volunteers' tickets, golfers' tickets, tickets for pleasure parties of not less than ten, tickets for soldiers, sailors, and police, privilege tickets for railway servants, commercial travellers' tickets.

The above list is by no means exhaustive, but it gives an idea of the extensive way in which traffic has been cultivated by judicious concessions to the public. Many of the above special rates represent single fares for the double journey, others a fare and a quarter, and the range extends to two-thirds and three-fourths of the ordinary fare. Privilege tickets for railway servants are issued at one-fourth of the ordinary first-class fares. Workmen's tickets are issued at unusually low rates, where the traffic is sufficiently large. Thus, the Great Eastern Company issues an immense number of these tickets to Liverpool Street at two pence for the return journey from points as far out as Enfield. The distance to that place and back is more than 21 miles, and the ordinary return fare 1s. 4d. These tickets carry, moreover, the privilege of alighting at, or returning from, any intermediate station. They are available only early in the morning on the outward journey, but can be used for return journeys after midday.

Tourists' tickets are issued from May to October inclusive, and are available for return at any date to the end of the year of issue. They always take the form of return tickets, and are issued only to seaside and other holiday resorts, but they represent a considerable saving on ordinary fares, as the following examples show:

London to	Ordinary Return Fare 3rd class s. d.	Tourist Fare 3rd class s. d.
Aberdeen	78. 9	56.0
Edinburgh	62. 8	50.0
Glasgow	62.11	52.0
Wick	106. 8	84.0

The tourists' tickets, besides, confer great freedom for breaking the journey, and even for going out of the direct route in certain cases;

for instance, passengers *via* Edinburgh may break their journey and proceed *via* Glasgow without extra payment. Tourists' tickets, and week-end tickets as well, are available for all trains.

Excursion tickets are now issued by all the leading companies at enormous reductions from ordinary fares, the extent of the reduction depending upon the interval allowed between dates of issue and return. The following are a few specimens of short-date and long-date excursion fares:

SHORT-DATE EXCURSIONS.

London to	Available for	Fare s. d.	Distance there and back. Miles.
Birmingham	1 day	5.0	226½
Liverpool	3 or 6 days	15.0	402
Manchester	1 or 3 days	10.0	378½
Blackpool	3 or 6 days	16.0	461
Derby	3 or 6 days	10.0	267½
Harwich	1 day	4.0	141
Brighton	1 "	3.0	102
Eastbourne	1 "	4.0	130
Hastings	1 "	4.0	152

LONG-DATE EXCURSIONS.

London to			
Keswick	16 days	25.0	598½
Llandudno	16 "	20.0	454½
Barmouth	16 "	20.0	514
Dublin	16 "	25.0	689
Belfast	16 "	25.0	585
Londonderry	16 "	30.0	891
Glasgow	16 "	25.0	804
Aberdeen	16 "	35.0	1081
Elgin	16 "	38.6	1241
Scarboro	16 "	20.0	509
Whitby	16 "	20.0	537
Yarmouth	16 "	15.0	243

The average fare is .37 of a penny for the short date and .43 of a penny for the long-date excursions—decidedly low rates of charge. Of course the excursion passengers have to travel by certain stated trains in most cases, though in the case of the long-distance excursions it is frequently an ordinary train that is specified. No luggage is allowed with excursion tickets, unless specially stated. On the other hand, each first-class ordinary ticket entitles the holder to take 120 pounds of luggage, each second-class ticket 100 pounds, and each third-class ticket 60 pounds without charge.

Reference has been made to the development of suburban business. It is an extraordinary fact that the two London underground railways last year carried 117,250,000 passengers, besides season-

ticket holders, the average sum received from each passenger having been 2.016 pence. Another company,—the Great Eastern,—whose suburban traffic has gone up by leaps and bounds of late years, carried last year more than 96,500,000 passengers, besides season-ticket holders. In 1888 it carried only 72,000,000, having thus shown an increase in only eight years of 24,500,000, or about 34 per cent. The season-ticket revenue of this company has also increased since 1885 from £163,777 to £259,358 for 1896, or by nearly 60 per cent. This stupendous suburban traffic has been built up by an enormous capital outlay on extensions of stations and widening of lines, while the good character acquired by the company for punctuality and cheap fares,—the direct consequence of able management—has contributed even more to produce this satisfactory result. The policy pursued not only has been to the public benefit, but has yielded the shareholders good results, as will be readily understood when it is stated that the dividends paid and the price of the ordinary stock of the Great Eastern were never higher than at present.

While the fares charged by English railway companies are undoubtedly tending towards a lower level, the *quid pro quo* received by the traveller is also increasing, so that the profit per passenger per mile is probably declining. But the growing cheapness and popularity of public travel are compensating the companies, so that more trains are run, and they are better filled. There is no doubt that the maintenance of these distinct classes on all trains has been, and continues to be, a great expense to those companies which still maintain them. The superior classes of carriages are often very scantily filled, or even empty, but they have to be run on all trains to meet possible requirements. The third-class carriages, on the other hand, are well filled. Thus the provision of the superior classes of accommodation involves an addition to the dead weight of the trains, for which the extra fares paid by the first- and second-class passengers certainly do not compensate. For this reason the companies whose second-class traffic had fallen off to the largest extent abolished it. The tendency is undoubtedly towards only one class,—the third,—though that eventuality appears remote. It is significant that the chairman of the Great Northern Railway—a company which has already abolished second-class except for London suburban traffic—lately made the following statement on this matter: "I confess I look with some doubt on the wisdom and policy of trying to assist any opposition to what is the evident trend of the public view as regards travel, and I certainly think the trend is rather in the direction of still further reducing the number of classes than increasing them. In other words, it would be easier for our traffic arrangements

if we could have but one class and carry everybody, and so fill our carriages reasonably full, whereas we now carry a good many compartments which are by no means full."

For many years competition in Great Britain has taken the form of extended facilities, especially to the third-class passenger, and this levelling-up has, together with declining fares, been the main incentive to the growth of the third-class traffic. Though first- and second-class fares have also declined, this movement has not been sufficiently strong to counteract the drain to the inferior class. It is generally recognized that, in proportion to the accommodation afforded, the third class is much the cheapest of the three, and the very fact that the superior classes of carriages are so scantily filled remains in many cases almost the only inducement to use them.

In regard to speed and safety the provision made for all classes of passengers in Great Britain is unequalled elsewhere in the world. The block telegraph system and interlocking of signals are universal, and the expenditure on the permanent way and rolling stock is most liberal. In the United States the same protective appliances and precautions are no doubt largely in existence, but they are by no means the rule. The obligations and restrictions under which the railways are placed by the law and government-supervision in the interests of safety are a burden on the railways, and those who attempt to prove that fares might be greatly reduced should bear this in mind. Public opinion on this matter has been educated to demand a high standard of safety, and the standard is rising with increasing cost to the railways. Considering the standard of comfort, safety, and speed afforded, on the average, by the railways of Great Britain, the fares bear comparison with those of any country. And, though various anomalies at present exist, the tendency is continually towards lower charges, combined with better accommodation in every respect—a policy which, while benefiting the public, is also yielding highly satisfactory results to the railways.

DEVELOPMENT OF MACHINERY FOR SHEET-METAL STAMPING.

By Oberlin Smith.

VERY many ages of nature's wonderful work in reproducing in a cheap way innumerable duplicate articles from the original germ or seed (which was not so cheap) were required as an example to conservative-minded mankind and womankind before they took a hint, and commenced to get the things they wanted cheaply and easily by causing the original pattern, or model, upon which great thought and expense were lavished, to reproduce its kind automatically.

One of the most notable examples of this great factor in any advancing civilization was undoubtedly the invention of the art of printing, whereby an elaborately-prepared engraved plate, or font of type, containing as it were much of the stored-up talent and brain-power of the artist who produced it, is endowed with the wonderful principle of indefinite multiplication.

After the art of printing, a new development of machinery for manufacturing processes commenced, but up to the middle of this century had not gone much farther, so far as metal-work was concerned, than the use of engine-lathes, planers, and drilling-machines for various paring processes, and the cutting and perforating of bars and sheets as representative of *shearing* processes. In the original form of these machines the reproducing principle was not manifested in any great degree, but it began to appear more particularly in the milling-machine, in which special-shaped cutters duplicated surfaces very many times before wearing out.

Later commenced the wonderful mechanical development, chiefly American, of the last few decades, in applications of the duplicating principle to numerous articles used in daily life, but more especially to such things as guns, sewing-machines, type-writers, mowing-machines, etc., which never could have developed into their present extensive use, had not the means also been developed for manufacturing cheaply. The most conspicuous instances of interchangeability of duplicate parts, with consequent cheapness and efficiency, were nndoubtedly those of the turret-lathe and of jig-drilling. In its more comprehensive sense, the latter includes the use of cradles, jigs, and other guiding tools for various processes beside drilling proper, and it should be said that essential to all the work in question

was the art of accurate gauge-making for the testing of the desired duplicate pieces and for the proper adjustment of the machines engaged in producing the same.

Later, and ministering in a still greater degree to the duplication of cheap pieces, came the art of press-working. Indeed, it may be said that many of the processes involved therein are more nearly akin to those used in printing than are any of the operations employed in the machine-work referred to. In witness of this, we have some embossing and coining operations which are almost identical with those performed by certain printing presses.

Within a very few years past the art of press-working metals has developed to a phenomenal degree, by reason of modifications which enable them to be applied in the production of many articles, or parts of articles, which until recently were made by the older and far more expensive methods of casting and forging.

In general, the processes in question may be roughly classified as *cutting*, in which are included punching and shearing; *forming*, including bending, embossing, and curling; *drawing* and re-drawing, which are more than forming, inasmuch as the metal is subjected to an extensive distortion or molecular flow, incident to the changing of a flat annular disc into a cylindrical, or conical, or approximately hemispherical, form of smaller average diameter, its surfaces being meanwhile rigidly confined to prevent wrinkling; and, lastly, *coining*, with which should be included drop-forging, the metal in both cases being treated as a liquid and simply pumped, as it were, into the shape desired, the molecular flow being very great, and the whole object being treated as is a pat of butter or a cake of soap in the molds provided for its new incarnation.

Among the numerous producing establishments extensively using the tools in question are those which make household- and kitchen-utensils, and various other tinware; brass-working shops; factories devoted to lamps and lanterns; clock and watch makers; silverware and jewelry manufacturers; railroad shops; bridge and girder mills; hardware and lock factories; canners of fruits, vegetables, fish, and meats; government mints; petroleum refineries; paint and varnish manufacturers; stove makers; the producers of agricultural implements; trunk makers; toy makers; zinc and copper workers; producers of wines and medicines; musical instrument manufacturers; and many of those who fashion articles in paper, cloth, leather, and soap, as well as in the various metals.

After ordinary shearing or punching, and also coin- and medal-making, the earliest extensive commercial adaptation of press-working was, probably, to the production of kitchen utensils. These, as is well known, are now produced seamlessly, from flat sheets, by

the drawing process, so that excellent utensils can be bought at the cheap stores which far surpass in beauty and cleanliness the vastly more expensive ones formerly soldered from numerous pieces. This process seems to have originated in France, and is now many years old, but the more recent development in metal stampings appears in the line of working cold steel into numerous complicated forms to replace castings and forgings.

In the pictures about to be described, attempt has been made to

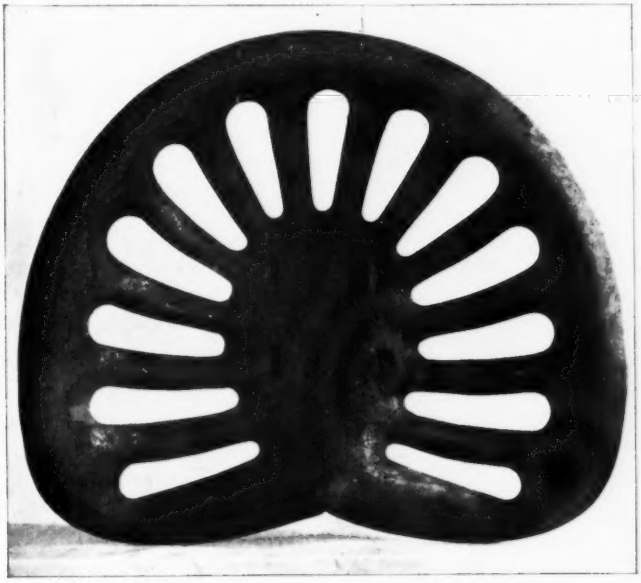


FIG. 1.

give examples of only a few of the articles referred to; in fact, not all the general classes of processes are included. Some of the stamped work shown, however, is sufficiently unique, at any rate to non-mechanical readers, to be worthy of the notice given it.

Pertaining to agriculture: Fig. 1 shows a mowing-machine-seat, made at two operations from cold steel, which is very much stronger, lighter, and more elastically comfortable than the cast-iron ones formerly used. Fig. 2 shows an outside view, and Fig. 3 an axial section, of a new horse-shoe calk made entirely in dies from a flat disc of cold steel, at several operations, even to the square hole inside

FIG. 2. FIG. 3. FIG. 4.

which fits the wrench by which it is screwed in. Fig. 4 shows a calf-weaner, whatever that term may imply, the writer not having sufficient knowledge of stock-raising to explain the details of this apparent barbarity.

Figs. 5, 6, 7, and 8 show well-known forms of can-tops and

FIGS. 5 TO 10.

-bottoms, which certainly are not unique, but any one of which a modern press run by a girl will produce from the sheet at the rate of from 10,000 to 20,000 a day. Were the tin-plate of which they are composed made, as it ought to be, and as inventive ingenuity will soon enable it to be, in long, reeled-up strips instead of small, square sheets, these presses could be automatically fed, and the articles produced at a much more rapid rate. Figs. 9 and 10 show zinc fruit-jar and oil-can tops respectively, and Fig. 11 a steel jar-clamp.

FIGS. 11, 13, 14, 15, AND 16.

Pertaining to the household: Fig. 12 shows a pressed-out lid for a butter-dish, this being cut and drawn in one operation from plate silver or other metal, and deepened and embossed at a second operation. Fig. 13 shows an ordinary gong-bell, which, until a very few years since, had to be cast in brass and turned all over, one skilled workman producing but a few dozen per day, whereas an unskilled boy can now turn out complete bells at the rate of 8,000 to 10,000

FIG 12.

per day. This is done at one stroke each, in ordinary cutting-drawing dies, from flat sheets of steel or brass, no turning afterwards being required, and the edge being incidentally hardened to a greater extent than the middle, with the result of an excellent tone from the cheapest sort of metal. When we consider the quantity of these bells in use, it can be seen that the saving is enormous. Fig. 14, illustrated on the page preceding this, shows an ordinary curtain-ring, which one cheap workman can make at two operations from thin sheet brass at a rate of many thousands per day. Figs. 15 and 16 show the first and last of a series of press operations, in making the rear part of an ordinary door-knob. Fig. 17 shows a knob of a different pattern, with the rear and front parts put together, the seam not showing; these pieces are made from the sheet in one or two operations, and the clinching also is performed in a press. Such articles until recently were cast and turned. Fig. 18 shows the first operation in the making of a coffin-plate.

Figs. 19 and 20 show two very different forms of nut-locks used on railroad tracks and in other places. The first is made from the

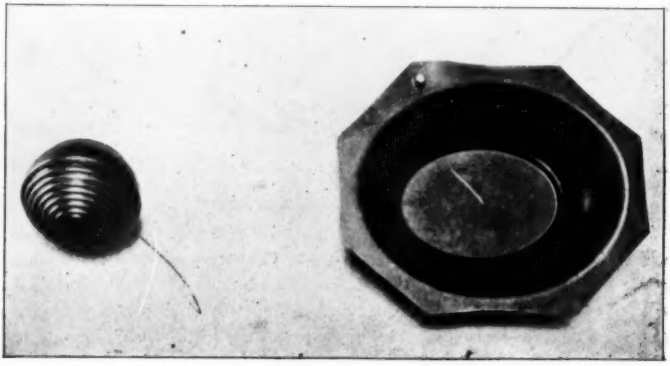


FIG. 17.

FIG. 18.

FIG. 19. FIG. 20. FIG. 21.

sheet at two or three operations, and the second from square bars in one or two operations.

Fig. 21 is an illustration of a new form of belt-hook produced in two operations from the sheet. Fig. 22 shows a seamless elevator bucket, produced from the sheet in three operations, as a substitute for the riveted buckets formerly, and still frequently, used. Indeed, many such articles have been, and are, made of malleable castings.

In our numerous dynamo and electric motor factories, vast quantities of sheet-iron notched discs are used for building up laminated armatures. One of these is shown in continuous form in Fig. 23, while in Fig. 24 is shown a segment of a built-up ring for the same purpose. These are now extremely commonplace objects, but they well illustrate the enormous importance of press and die work in one of the greatest industries of the age.

FIG. 22.

In military, as well as civil, life we find numerous adaptations of stamped work, not only in a little belt-clasp as shown in Fig. 25, and in buttons, canteens, sword-scabbards, etc., used upon the person, but in the vastly more important line of cartridge making. Indeed, our modern system of loading small arms could not exist were it not for the thousands of presses daily engaged in drawing the copper shells which serve as the skele-

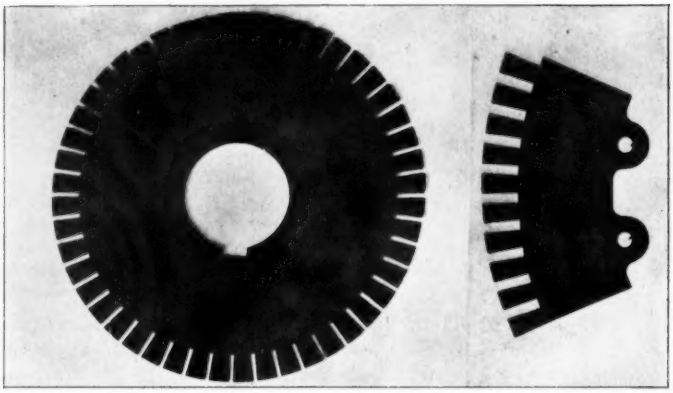


FIG. 23. FIG 24.

tons for our lead- and powder-charged cartridges. If we look further, we find that numerous parts of guns and pistols are cut from the sheet, or, in more numerous instances, made nearly to shape in a drop press.

Considering larger game, it would hardly have been thought heretofore that steel cannon would require the use of presses and dies, except huge squeezing presses as substitutes for steam-hammers in compressing the ingots. It now appears, however, that some genius has recently devised a cannon which seems practicable, made of numerous discs of sheet-steel—which, of course, can be cut very rapidly, cold, in an ordinary press—so piled together that their united thicknesses represent the length of the gun, the whole structure being aligned by a central tubular core and held together by external bolts.

FIG. 25.

Fig. 28 shows a group of spring-plates, so called, used in connection with the gangs of springs in the trucks of railroad cars. Fig. 29 shows a stake-pocket used upon the sides of

platform cars. Not only have such articles as these, quickly pressed from sheet-steel, almost taken the place of the cast ones used a few years ago, but many truck-frames, and even car-wheels themselves, are now being made by the same methods.

The remaining pictures refer entirely to bicycle work, but do not by any means cover the ground. An analysis of this wonderful, popular, and now very-much-cheapened machine will show that it could hardly exist except for press-working methods—at any rate, not in its present light and low-priced form, where we see a vehicle of remarkable capabilities weighing 25 pounds and in some cases retailing as low as $25, notwithstanding the fact that it is made of hundreds of pieces of steel, with wonderful refinement in strength, accuracy, and smooth and noiseless running. In Figs.

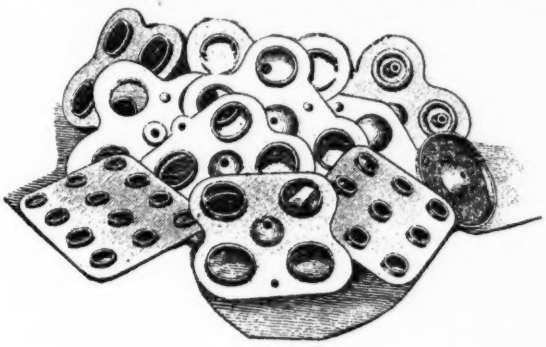


FIG. 28.

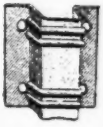


FIG. 29.

31, 32, 33, 34, and 35 are shown in their natural sequence (some intermediate pictures omitted) five of the dozen and more operations necessary to produce a complicated "crank-hanger" from a flat piece of steel, the operations all being conducted cold.

Fig 36 shows a small double dovetailed tongue, which, in the crank-hanger mentioned, is used for locking the joints together, although in most cases this additional fastening is omitted. An article of this kind is, of course, brazed in all its joints, after being formed to shape. Figs. 37 and 38 show the two forming operations, used after the blank has been cut to shape, in making another well known fitting used in the frames of bicycles.

Fig. 39 shows another familiar bicycle fitting, made in one piece at several operations. The ingenious slitting and looping in the centre of this piece to obtain a tapped hole for the rear-axle adjustment-screw show an ingenious adaptation of one of the capabilities

FIGS. 31 TO 36.

of sheet-metal work, where ordinarily a solid and thickened-up boss would have to be drilled and tapped.

This, and the two fittings just described, are substitutes for the vastly more expensive fittings formerly employed, and still to a considerable extent used on all sorts of bicycles. All of these were formerly forged roughly to shape, the cavities being drilled from the solid, and

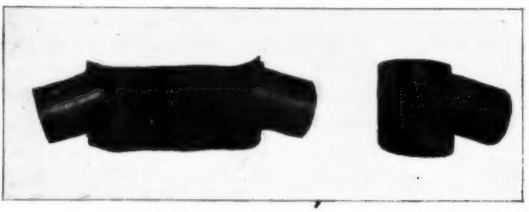


FIG. 37. FIG. 38.

the outside finished by turning, milling, etc. Figs. 41, 42, 43 and 44 show the four operations necessary for producing a bicycle foot-rest, which obviously can be made at an extremely low cost. Some of these, indeed, are retailed at five cents a pair—duly nickel-plated and equipped with bolts and nuts.

FIG. 39.

Fig. 45 shows a side-piece of one popular form of bicycle pedal, which is simply cut from the sheet at one operation at the rate of perhaps 100 per minute for each press, several presses being attended by one operator. Fig. 46 shows a unique form of bicycle pedal

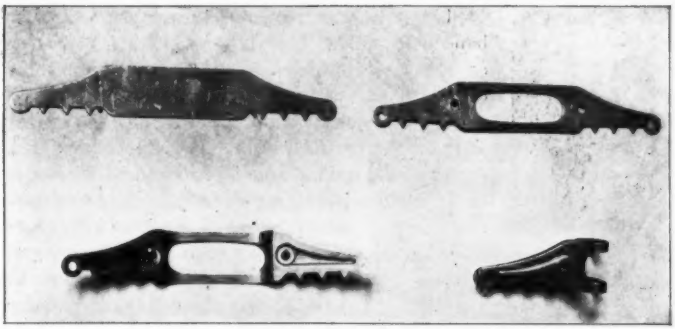


FIG. 41. FIG. 42.
FIG. 43. FIG. 44.

frame, many of which, of the same appearance, are cut out from a flat sheet, bent around, and electrically-welded together. This particular

FIG. 45. FIG. 46.

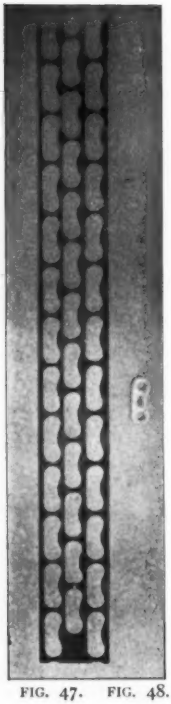


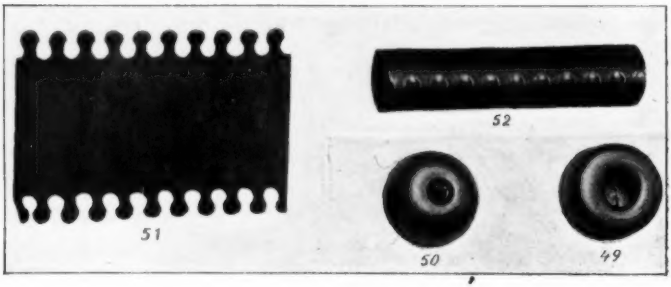
FIG. 47. FIG. 48.

one, however, is seamless, and is made by a new process, cold from the sheet.

Fig. 47 shows a piece of scrap, and Fig. 48 one of the bicycle-chain links punched therefrom. Strips of this sort can be fed to a press running at the rate of more than 100 strokes per minute; and dies can be set in gangs, as shown, to cut as many links at a time as desired, the number in this particular case being three. The apertures in the link can be made at the same time, properly-set gangs of punches perforating the metal a stroke or two ahead, and the contour of the link afterward being cut around them,—a method which is known as the "progressive" system of cutting dies.

In Figs. 49 and 50 are shown a ball-cup and handle-ferrule for bicycle work, either of which can be rapidly made cold in from one to three operations.

Figs. 51 and 52 show the first and last operations on a peculiar kind of bicycle tube. The metal is bent around and interlocked with a series of dovetailed joints, all the operations being performed in ordinary presses and the joint afterwards brazed. Fig. 53 shows, in a nested group several of the successive operations used in tube drawing, while Fig. 54 shows a cup similar to the largest one in the group just mentioned, partly turned inside out, the turning operation being effected after the manner in which some people pull off



FIGS. 49 TO 52.

their stockings. In this case the motion of the press was arrested midway, and the cup taken from the dies, to show its incomplete condition. A large portion of all the steel bicycle-tubing now made, including much of the high-grade, is drawn cold from flat sheets by the system indicated—the turning inside out not being essential to the system, however, and occurring only upon special occasions. The fact that this method is so extensively used indicates that it is cheaper and better, on the whole, than the system of drawing tubes from hollow cast or forged ingots. It is strictly press and die work, especially in the first stages of drawing the cups and reducing them until they approach the proportions of a tube proper.

Fig. 55 shows a bicycle hub made from steel tube, by swelling out and upsetting the metal, in an ordinary press, to form the flanges. A still more elaborate form of hub has recently been devised, in which it is not necessary to have a separate lining piece, the various thicknesses required being drawn in a short special tube,

FIGS. 53 AND 54.

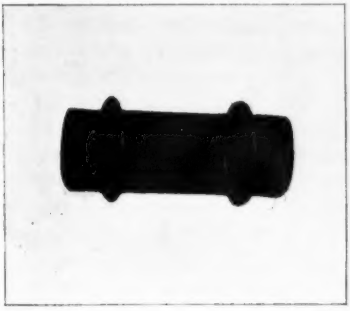


FIG. 55.

before the flanges are made. Such a hub is an excellent substitute for those made from solid metal, some of which are forged roughly to shape and then drilled and turned, while others are drilled and turned at the same operation from a bar large enough

to cover the flanges. In either of these cases, the waste of metal is enormous, and the labor and time very considerable.

In general, mechanical analysis of the modern bicycle shows that a large proportion of its hundreds of pieces may be made, wholly or partially, by some of the processes we have been considering, the principal exceptions being its studs, bolts, etc., which are produced in rapidly-working automatic turret-lathes. Even the spokes of the wheels, ostensibly of wire, are reduced in dies by a swedging operation closely resembling the action of a press. The leather of the saddles is first cut, and afterwards formed with presses and dies, and wooden rims are confined in special dies while being glued, as are also the rubber tires themselves during the vulcanizing process.

It is safe to say that, without the aid of press-working processes, the modern bicycle would be but a luxury for the rich, and not, as now, the vehicle, companion, and friend of the poor.

It must be remembered that, with the stamping methods we have considered, there is not only a uniformity of production which enables the different pieces of an article to be assembled without machine-work and hand-fitting in a way that is impossible with rough forgings or castings, but that the labor item and the general "expense rate" of the factory are reduced in an almost marvelous degree. The various operations in press-work can easily be performed at the rate of 1,000 to 100,000 per day of ten hours, 10,000 being a fair average for light articles by hand-feeding, and this with an unskilled operator. Such rates of production are entirely unapproachable by most of the other methods used in manufacturing metals.

The production of very many of the necessities and luxuries of our modern civilization by machinery such as we have considered has been so wonderfully cheapened as to create an enormous demand for things formerly unattainable by the masses. This has not only added to the sum of available happiness, but has furnished employment to vast numbers of operatives in the various industries concerned, making the subject under discussion an important factor in problems of economic science. The special development in this line which has occurred in America within the last few decades may perhaps have contributed considerably to the economic forces which have acted to produce the better general conditions and the higher rate of wages enjoyed by American workmen, in contrast with those of the east, and enabled the United States to export so many of their manufactured goods, in spite of the cheaper labor existing abroad.

THE RECOVERY OF BY-PRODUCTS OF THE BLAST FURNACE.

By A. Humboldt Sexton.

IN England and in America, where the blast furnaces are fed with coke, the only by-product is the gas, and for many years this has been utilised almost universally for heating the blast and for raising steam; but in Scotland and some other localities, where the fuel used is raw coal, the gas carries with it tarry matters and ammonia to a considerable value, and these, until recently, were allowed to be lost.

The recovery of every possible item of value is a matter of continually increasing importance in the iron trade. It has recently been pointed out in these pages* that, "if the British coke industry were to utilise by-products and waste gas generally, they would be able to furnish considerably cheaper supplies of coke to iron smelters, and this is a reserve of strength that can always be resorted to in case of need—the more readily as most of the large smelting firms have their own collieries and coking plants. There would be no good reason why pig-iron makers in Cleveland, for example, should pay 12s. to 14s. per ton for coke on which the railway transport is only 2s. 6d. per ton, if the coke-maker took advantage of his opportunities to economise in the process of coke making, and if British smelters were satisfied to accept and use coke from by-product ovens, as is done in Belgium and Germany."

Ordinary Scotch splint coal, such as is used in the blast furnaces, yields only about 60 per cent. of coke,—sometimes less,—and, as the fixed carbon is the only portion of the fuel which is of any use in the blast furnace, a large quantity of coal—from 32 to 36 per cent.—is required for each ton of iron produced. The coal contains about 1.4 per cent. of nitrogen, and, if the whole of this were evolved as ammonia, it would yield about 143 pounds of ammonia sulphate for each ton of coal consumed. In practice only about 10 per cent. of the nitrogen is evolved as ammonia; so that the yield of sulphate is only about 22 to 26 pounds for each ton of coal used. This seems a very insignificant amount, but, when the large quantity of coal consumed in an ordinary blast furnace is taken into account, it will be seen that the total yield may be very considerable.

* J. Stephen Jeans, in The Engineering Magazine for January, 1898.

No doubt many iron-masters, seeing the tar accumulating in their gas mains, and hearing much of the great value of gas tar, had visions of the profit they might make by recovering and selling this with any possible ammonia; but from dream to realization is a long step, and no one cared to be the first to attempt it, for the outlay would certainly be very large, and the profit to be realized was problematical. Under such circumstances some one more daring or more far sighted than his neighbours is sure to arise and carry out the work about which they are hesitating; and so it proved in this case, the pioneers being Messrs. Alexander and McCosh, of the great firm of Baird & Co., Limited.

The Messrs. Baird for nearly seventy years have been in the van of the Scottish iron industry. They were the first manufacturers to take out a license to use the hot blast under Neilson's patent at the Gartsherrie works, then just started, and in 1879, almost exactly fifty years later, they decided to make the most important advance that has been attempted in the industry since that time.

When the problem was studied, the difficulties were apparent enough, the most important being the vast amount of gas which would have to be dealt with and the absence of data as to the methods of removing so small a quantity of condensible matter from so large an excess of gas. In the gas works each ton of coal yields about 10,000 cubic feet of gas, which carries with it the products to be recovered; but in the blast furnace each ton of coal yields about 12,000 cubic feet of gas with only about the same amount of recoverable material scattered through it. Then the total amount of gas to be dealt with is very large. A furnace consuming 80 tons of coal a day would give about 9,600,000 cubic feet of gas in that time. This volume may be best realized by comparing it with the amount of gas made for the supply of a large city. The gas department of the corporation of Glasgow supplies a population of nearly 1,000,000 people, and the total amount of gas made in all its works per day is about 12,400,000 cubic feet,—much less than the amount produced by two blast furnaces

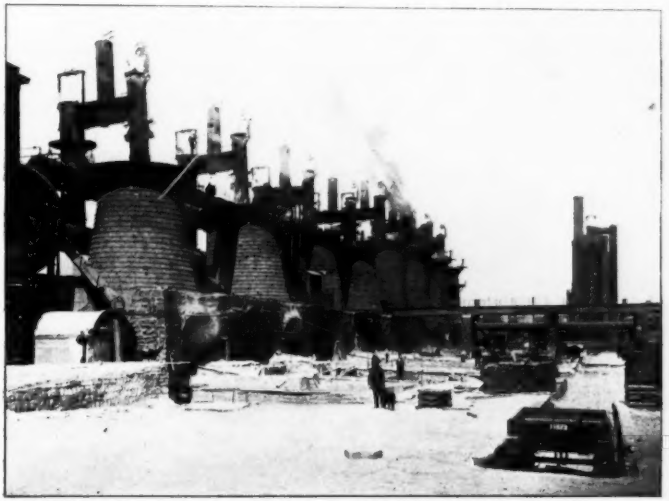
The works at Gartsherrie, to which the recovery plant was to be applied, consisted of sixteen furnaces, arranged in two rows of eight, one row each side of the yards, and it was decided to begin with one side only, eight furnaces.

In 1879 the furnaces standing were very small and of an old type, each consuming about 60 tons of coal per day. These furnaces have now been replaced by others of more modern design and larger size, but the recovery plant at first erected is still in use.

It will be seen that the plant had to be designed to deal with about

130,000 × 60 × 8 = 62,400,000 cubic feet of gas per day; and, as the replacement of the furnaces was then in contemplation, it was necessary to give it somewhat greater capacity than would otherwise have been necessary.

After a large number of laboratory experiments, some of them on a very large scale, Messrs. Alexander and McCosh decided that the plant should be built on the principle in general use in gas works,—*viz.*, that the gas should be well cooled, and then washed with water. The wisdom of this selection has been amply justified by experience, as all the recovery plants now in use are based on this principle, while



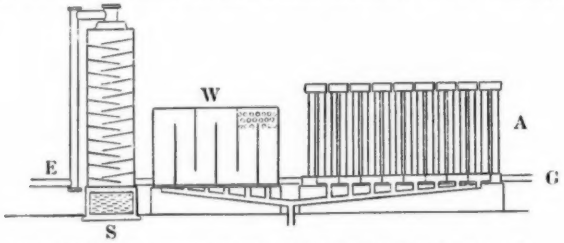
GENERAL VIEW OF ONE SIDE OF THE GARTSHERRIE WORKS, AS IT WAS IN 1880.

other types have been tried and abandoned. The chief problem to be solved is this: Given 130,000,000 to 150,000,000 cubic feet of gas per day, leaving the furnace at a temperature of about 600° F., and having to be cooled to, say, 60° F., whereby its volume will be reduced to 60,000,000 or 70,000,000 cubic feet, to cool it, and then to remove the small quantity of condensible products disseminated through it.

It need hardly be said that no experimental data existed, either as to the amount of cooling surface that would be necessary, or the amount of washing-water that would be required; so the designers had to ascertain these for themselves. The cooling was comparatively

easy, but the removal of so small a quantity of condensible matter in so large a mass of gas presented great difficulties, for, even after the temperature has been so reduced that condensation must be complete, the condensed products show but little tendency to settle, but are carried forward by the gases in the form of very finely-divided mist, which can be removed only by thorough washing or scrubbing.

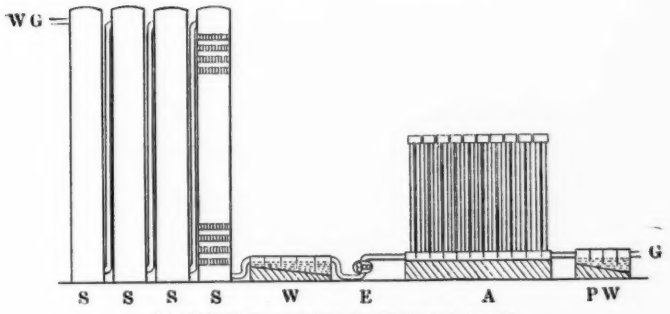
Messrs. Alexander and McCosh adopted very thorough cooling, and a final scrubbing, as their leading principle. Messrs. Dempster, who were the next to erect a plant, adopted cooling, washing, and scrubbing, while Mr. Gillespie, who is the latest comer, dispenses altogether with the scrubbers, and depends on cooling and washing. Almost all the Scotch iron works are now fitted, or being fitted, with recovery plant. The various works of Messrs. Baird & Co. have the Alexander and McCosh plant; most of the others have the Dempster plant, while the recently erected plants are those of Mr. Gillespie.



DIAGRAMMATIC SECTION OF THE ALEXANDER AND McCOSH PLANT.
A, atmospheric condenser; W, water condenser; S, scrubber; G, gas main from furnace; E, main to exhaust.

The gas leaving the furnace passes through a dust catcher, and then, by a long main, to the first condenser; in so doing it cools somewhat, and a certain amount of sticky tar deposits. In some works the hot gas is made to assist in the dehydration of the tar before it enters the atmospheric condensers. In the Gartsherrie plant the gas passes at once to the cooling tubes, but in the others it is made to pass through a primary washer filled with tar, by which most of the dust which has not been caught in the catcher is kept back, and some of the tar is collected. This washer may be made to act as a very effective valve or tar seal, cutting off the communication between the furnaces and the condensers when necessary.

The first cooler consists of a series of vertical iron pipes. In the Gartsherrie plant these are 40 feet high and 2½ feet in diameter, and are 200 in number, arranged in twenty rows of ten each, so that every particle of gas has to travel through twenty tubes alternately up and down. The tubes are so arranged that the condenser can be sprayed



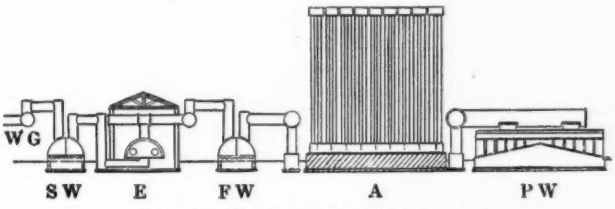
DIAGRAMMATIC SECTION OF DEMPSTER PLANT.

PW, primary, or tar, washer; A, atmospheric condenser; E, exhaust; W, washer; SSSS, scrubbers; G, gas main from furnaces; WG, washed gas to stoves, etc.

with cold water in hot weather. The gases enter at about 400° F., and leave at about 120° F.

In the other forms of plant the atmospheric condenser is on the same principle, but the number and size of the tubes varies with the amount of gas to be treated. In the Gillespie plant, the tubes, instead of standing on one large tar box, stand each row on a separate box, so that any one row can be shut out of use for cleaning or repairs without interfering with the rest. In the Gartsherrie plant still further cooling is used, the gas from the atmospheric condensers passing into a water-cooler,—a large iron chamber 45 feet long, 45 feet high, and 18 feet broad, crossed by 2,700 iron pipes, through which water is kept constantly circulating, the water entering each tier of pipe at the further end and travelling backwards and forwards across the chamber, while, by means of suitable partitions, the gases are made to circulate up and down on their way, and so come in contact with the whole of the pipes. The gases leave this condenser at about 60° F.

In the Dempster plant this second cooler is replaced by four sets



DIAGRAMMATIC SECTION OF GILLESPIE PLANT.

PW, primary washers; A, atmospheric condenser; FW, first washer; E, exhaust; SW, second washer; WG, washed gas to stoves, etc.

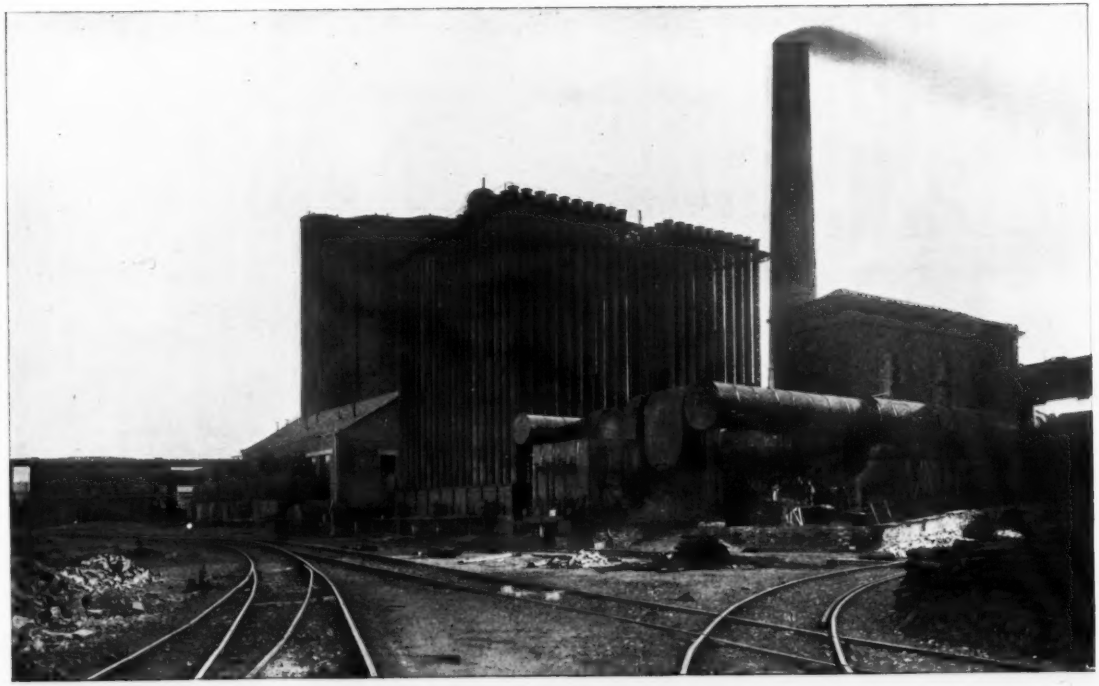
of washers, which are crossed by perforated plates so as to break up the gas and, as far as possible, wash out the tar before it passes to the scrubbers. Neither the complete cooling of the Gartsherrie plant or the combined cooling and washing of the Dempster plant is sufficient to remove the tar and ammonia ; so the gas is next passed to the scrubbers, of which, at Gartsherrie, there are two. The first is 80 feet high and 25 feet square, while the second is 60 feet high and 20 feet square, both being crossed by a large number of sloping perforated shelves. Down both of them a rain of water is kept constantly falling.

In the Dempster plant four scrubbers are used. These are about 100 feet high and 12 feet in diameter and are packed full of wooden boards set on edge—about three hundred tons of wood being used—

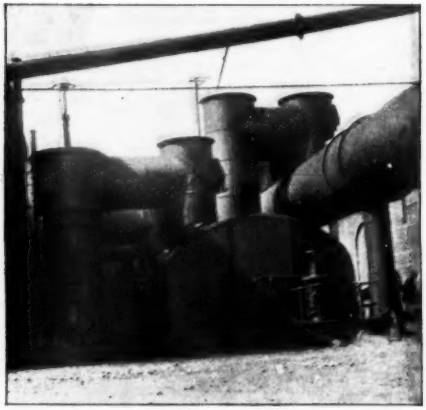
GENERAL VIEW OF THE ALEXANDER AND McCOSH PLANT AT GARTSHERRIE.

so as to effectually break up the gas and bring it in contact with the water. The gas ascends the four scrubbers successively. The liquor from the last scrubber is pumped up to supply the next, and so on, the gas travelling in one direction and the washing-water in the other.

At first sight it seems that washing—*i. e.*, bubbling the gas through water—should be more efficacious in removing matters in suspension than scrubbing with a shower of descending water, but, as a rule, this has not been found to be the case. When gas bubbles through water, only the surface of the bubble comes in contact with the water, and thus solid or liquid matter may be carried through untouched. If the gas could be broken up into small enough bubbles, washing could be made quite as effective as scrubbing. Mr. Gillespie, in his plant, does away altogether with the scrubbers, substituting



GENERAL VIEW OF THE DEMPSTER PLANT AT GLENGARNOCK.



THE GILLESPIE WASHERS.

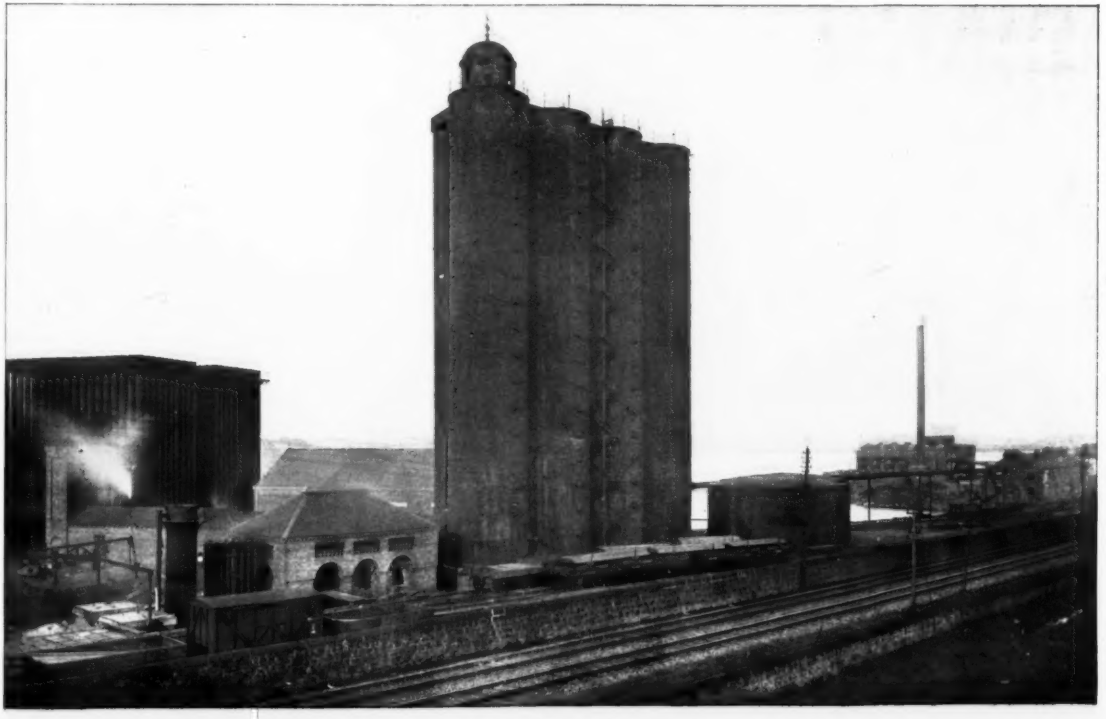
washers of a peculiar form. The chambers of the washer are divided by plates having finely-serrated edges, so that the gas is broken up, and at the same time the current of gas is much reduced in speed by making the area of the washer very large in proportion to that of the mains by which the gas reaches them. These washers are said to be very effective in removing all tar and ammonia, two sets of washers being used in conjunction with one set of atmospheric cooling-tubes.

Whatever form of plant may be adopted, the resistances introduced are so great that the gas must be drawn through and carried forward to the boilers where it is to be burned. Various forms of exhaust are used,—Root's blowers, fans, and cylinders, the last named seeming the most popular.

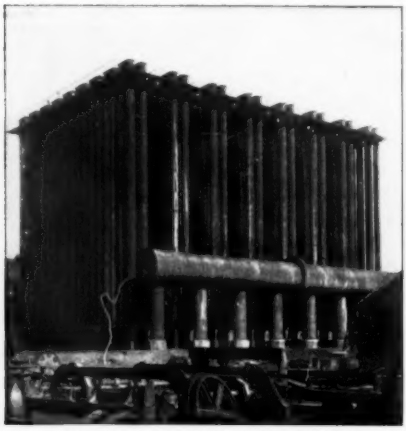
The condensed tar and ammonia water are run into large settling-tanks, where the tar sinks to the bottom, and the two are separated in storage tanks. The three products so far obtained are gas, tar, and ammonia liquor.

The gas, as it leaves the exhaust, passes at once to the boilers, or stoves, and is there burned. No doubt the removal of the tarry matters somewhat reduces the heating power of the gas,—how much it is impossible to say,—but this is compensated to some extent by the much greater dryness of the gas. The gas is much dryer than it would be if passed direct from the furnace, because it is much cooler, and the amount of water a gas can carry depends on its temperature. The washed gas is quite good enough for all purposes for which it is required, and, being free from tar and dust, can be used direct in the gas engine, which is a much more economical method of using the gas than burning it under a boiler. This plan has recently been carried out at the Wishaw works of the Glasgow Iron and Steel Company for lighting the works by electricity, and has been in every way successful.

The power developed in the gas engines has been equal to 1



THE SCRUBBERS, GLENGARNOCK.



GILLESPIE ATMOSPHERIC CONDENSERS.

electrical h. p. h. for each 1.8 pounds of coal consumed in the furnace, assuming that each ton of coal gives 130,000 cubic feet of gas. There promises to be in the near future a large development of this means of obtaining power, as the amount of energy obtainable from the blast furnaces of Scotland would be very large.

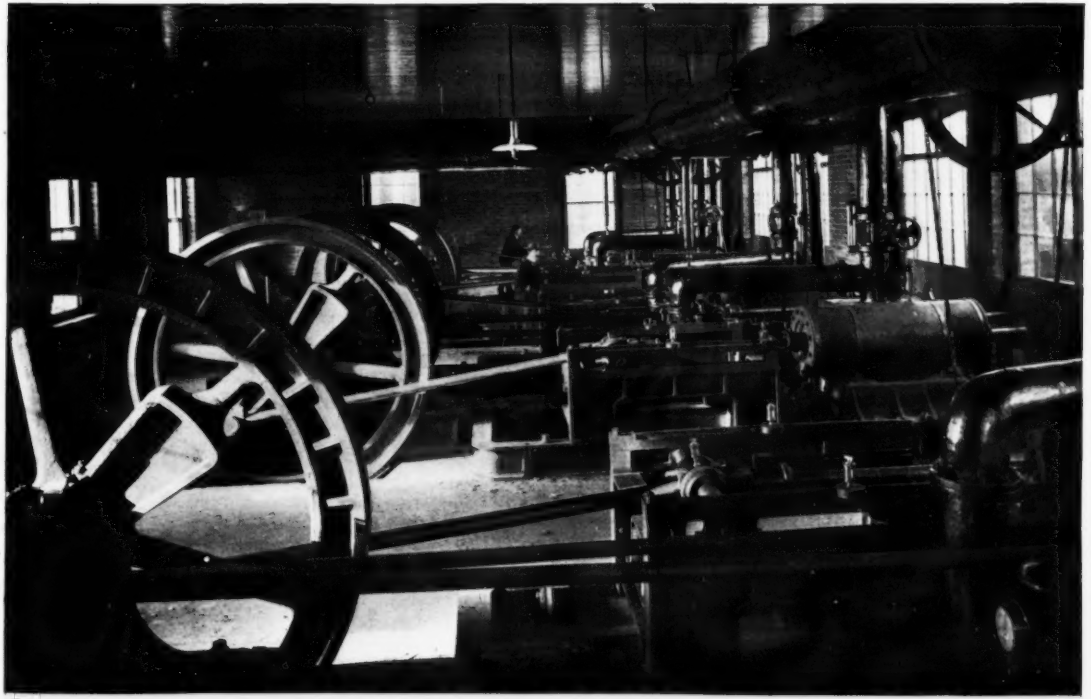
The water containing the ammonia is heated to expel the ammonia, continuous evaporators being used, in which the descending liquor falling over suitably-arranged plates is met by an ascending current of steam.

The ammonia is passed into acid, in lead boxes, and the crystals, as they form, are either pushed or automatically discharged into draining vats, from which they pass to the stove, the draining being in some cases facilitated by the use of a centrifugal drying-machine.

The amount of sulphate obtained is from 22 to 25 pounds per ton of coal consumed, depending on the quantity of nitrogen contained in the coal, of which it represents 15 or 16 per cent., and perhaps somewhat on the nature of the coal and on the temperature to which it is heated, a high temperature tending to reduce the quantity of ammonia. There is practically no loss of ammonia, the escaping gases being almost free from it.

In the gases as they leave the furnace the ammonia is present almost entirely as free gas, the temperature being too high to allow combination with the carbon dioxide, though no doubt traces of sulphate and cyanide may be present. To decompose these a small quantity of lime was always added before evaporation, but the amount of fixed ammonia was so small that this has now been generally abandoned.

The tar obtained amounts to about 40 gallons, or, say, 400 pounds of green tar for every ton of coal consumed, but of this a very large proportion is water. The tar is pumped into boiler-shaped stills, and heated to expel the water. The resulting anhydrous



THE EXHAUST HOUSE, GLENGARNOCK. THE GAS CYLINDERS ARE OUTSIDE OF THE BUILDING.

or boiled tar amounts to about 40 per cent. of the total, or, say, 16 gallons for each ton of coal consumed.

The tar is entirely different from coal-gas tar, and for some time it was difficult to dispose of it, or to use it. It is almost free from the aromatic hydrocarbons, such as benzine, anthracene, etc., and therefore is valueless for the manufacture of the many coal-tar derivatives. It contains phenols, however, and, on distillation, yields oils which can be used for various purposes. Mr. Watson Smith gave the results which were obtained by the distillation of a sample of the tar as follows:

Below 230°, water	30.60	% of distillate
oil	2.91	" "
230° to 300, oil	6.97	" "
300°, oil	13.02	" "
till oils solidify on cooling.		
Oils solidifying on cooling, a soft paraffin scale	16.75	

The coke left being 21 per cent. of the weight of the tar.

The dehydrated, or boiled, tar is distilled in large stills, the oils being either collected altogether or separated into light and heavy oils. The distillation is stopped while the pitch is still liquid enough to run out, but solidifies on cooling. In one works 10 gallons of oil and 119 pounds of pitch were obtained for each ton of coal consumed.

The oil can be used for various purposes, the principal being as a fuel, for which it is well suited, or as an illuminant in the various blast lamps, such as the Lucigen. At some works the oils are separated into Lucigen oil, which has a specific gravity of about .970,—suitable for the lamps,—and creosote oil, having a specific gravity of about .989, and containing phenols. The latter is used as a disinfectant and as a preservative for timber, and from it an important disinfecting preparation is made.

The pitch is in considerable demand for the manufacture of fuel blocks, or briqettes, which are now made in considerable quantities from small coal obtained from the coal washers.

The recovery of the by-products from iron blast furnaces has now become general in Scotland, almost every works having its own plant, sometimes worked by the iron-masters themselves, but more usually belonging to a subsidiary chemical company, which purchases the products and returns the gas to the works. The value of the recovered material is considerable, and the introduction of the recovery processes has done much to help the Scottish iron industry.

The following figures have been officially published with reference

to an installation in a works of four furnaces, all of which were making haematite pig:

Coal consumed.....	2,000 tons per week		
Pig iron produced	1,400 " " "		
Pitch recovered.....	100 " " "	value	£120
Oil " 20,000	gallons,	"	£125
Sulphate of ammonia....	20½ tons,	"	£225
			£470

The wages and other costs of working the plant are put at £30, and the cost of acid at £20 10s., leaving a handsome balance for interest, depreciation, and profit.

The cost of the plant is, of course, large, varying from £5,000 to £10,000 per furnace, so that the interest at five per cent., assuming the higher figure, amounts to about £38 per week.

The recovery of the by-products has thus introduced a new industry into the west of Scotland, and, by the freeing of the gas from tar and dust, has opened new channels for its use.

It is no doubt true that practically the same products can be recovered from the coke ovens where coke is used for the blast furnaces, but that leaves the blast-furnace gas unwashed, and therefore is unsuitable for direct use in the gas engine. It becomes an important question for iron-masters whether, whenever a suitable coal can be obtained, it is not more economical to use it direct, in spite of some disadvantages, rather than to coke it in separate ovens?

THE ADJUDICATION OF WATER RIGHTS IN IRRIGATED REGIONS.

By Elwood Mead.

THE diversity and value of the returns from irrigated agriculture have been much dwelt on, and its superiority to that dependent on rainfall has often been manifested. Of late, however, in the United States, it has been the prolific source of another product, not so desirable, and not usually referred to in this connection. I refer to controversies and law-suits over water rights. As the far east has afforded studies for the engineer in an irrigation practice which is yearly attaining more importance in Europe and in America, the far west, in turn, may throw important light on another phase of the problem.

The growing volume and cost of this litigation, the number and complexity of the questions raised, and the uncertainty which exists as to the time and manner of their final determination render this feature of the agricultural development of the arid States a subject of grave concern to all interested therein. It is already a heavy burden on users of water, a menace to progress, and, unless brought to an end, will seriously affect the security and value of every irrigated farm. In a recent discussion of this question a candid and careful investigator expressed the opinion that the expenses due to defective laws, and especially to litigation over water rights, are already greater in the United States than the total cost of building ditches and reclaiming land. If this is true now, while they are yet in the period of construction and before the banks of the majority of canals have ceased to settle, we may well look with apprehension to the results which are likely to follow, when expanding settlement and growing scarcity shall give greater value to the water-supply now being fought for.

There is no necessity for such results. In every arid State water is a free gift to the appropriator, and, so long as the public gets nothing for the water diverted, it should not cost more to fill ditches than to build them. There is something radically wrong with a system which makes litigation cost more than excavation. That this something lies in defective laws is shown by the fact that these controversies exist only in certain States.

It is the purpose of this paper to outline the nature of these controversies, and to show that wherever they have arisen vicious or inadequate laws have been the cause. Before doing this, it may be

well to explain to those who live in humid lands that in the arid States it is water, not land, which gives the irrigated farm its value. Of land there is a surplus; of water, a scarcity. Water must be had to render the land either habitable or productive. Every field of grain in the valley of a river is the result of its bounty. If water is denied, crops wither, and the cultivator has no reward. Hence, titles to water are more important than deeds to land. Whoever controls the river practically owns the land through which it runs, no matter who holds the patent thereto.

There is another vital difference between farming in arid and humid lands. In the latter success depends upon individual effort; in the former, on wise laws and adequate industrial organization. The farms along many arid rivers are counted by the thousands; hundreds of ditches supply them. The value of every one of these farms depends upon the just and effective division of the stream, delivering to each user his proper share of the snow that falls on distant mountains. To do this, water must often be carried past scores of empty ditches with thirsty fields below them. The region to be supervised to make a just division of a single stream often embraces many thousand square miles, extends for hundreds of miles along water-courses, from the hills where the waters are collected to the valleys where they are distributed, and frequently crosses county and State boundaries,—in a few instances, international ones. The multitude of rights involved are to a common supply fluctuating in volume from month to month and day to day, while the needs of its users change with every summer's wind or passing cloud.

To insure the success of this division certain things are indispensable. The rights to be observed must be definite and stable, so that each user's share may be beyond dispute. There must be adequate means, and administrative ability of high order to secure their enforcement. The individual farmer or ditch-owner can do nothing. There must be State, or community, control.

Of necessity, therefore, the social and industrial institutions of irrigated lands differ widely from those of humid lands. Laws to control this industry should recognize and conform to these necessities. The importance of this was not realized by the pioneers of the arid western United States.

In addition to lack of knowledge of the laws of other irrigated lands, or the needs of their own, the early American irrigators and lawmakers were not greatly concerned about the welfare of future generations, or engaged in a conquest for their benefit. They endured the hardships and privations of this region not so much to develop its resources as to possess them. That the streams of this vast domain are its life-

blood, a great public heritage on the wise use of which depends the ultimate number, comfort, and prosperity of its people, was a conception at first held by a few. To the multitude they were a store of latent wealth to be secured in the most direct way and at the least possible cost, and, when so secured, to be bought and sold, like farms or mines, wheat or corn. Those holding the latter view shaped the earlier laws, and secured recognition of the doctrine of speculative control from the courts; though they were successful, the obstacles to be overcome proved serious.

It is hard to define by law the limits of this ownership. The nature of the title to mines, corn, and cattle is easily understood, but it is otherwise with a river. The water of to-day is not that of yesterday. To give patents to snow which may or may not fall next year is an innovation which lawmakers have been disposed to avoid. What has been done in all States, except Wyoming, Utah, and Nebraska, is to provide for the *appropriation* of water, the beginning of this appropriation to be a filing similar to a mineral location, while its completion, and the nature and amount of the right, are to be determined by the courts. Under the most favorable conditions the framing of these court decrees would be exceptionally difficult. The conditions which have prevailed in the western States have made satisfactory decrees almost impossible. Nearly every appropriator has a different meaning for the term. The laws which assume to define it do so in terms so loose, vague, and often contradictory that it may mean absolute ownership, a right to use equivalent to such ownership, or a right to use alone. It is small wonder, therefore, that courts have not agreed in their interpretation of these statutes. Out of this lack of exactness has come the controversy between those who believe that water should remain public property the right to which belongs to those who use it, and those who believe that water should be personal property, to be bought or sold by those who can secure a title thereto.

To those not familiar with the value of water in irrigated lands the significance of this situation may not be apparent. All, however, know how important are stable and definite titles to land, and how quickly values shrink and improvement ceases when any cloud hangs over ownership. Because of this, the American government has adopted the most careful, systematic, and expensive methods for the survey and disposal of the public domain, in order that both the boundaries and titles to the land parted with may be known and respected for all time. If, instead of this admirable system, with the peace and security which has gone with its operation, the government had pursued a land policy similar to that of many arid States in the management of streams, the government would have made no surveys to determine the areas or

fix the boundaries of the tracts of land to be disposed of. It would have established no land offices and issued no patents. Instead, there would have been laws throwing the whole area open to free appropriation without restriction on either the location or the limits of the land which each individual or corporation might acquire. Appropriation would have been inaugurated by driving a stake and posting a notice somewhere on the land appropriated, setting forth the name of the appropriator and the number of acres or square miles appropriated. Next, the claim would have been recorded in some local office having no control over the land. Within a reasonable time thereafter, which might be one year or ten, a fence would have been built around the land appropriated, whereby the appropriator would have become entitled to a patent. This patent, however, would not have come from the sovereign power that made the law, but in the shape of a court decree, issued after a contest with other claimants of the same land.

The operation of such a land law would correspond closely to the history of these water laws. So long as the number of appropriators was limited, and all were engaged in driving stakes and recording claims, it would be immensely popular. Appropriating land would appear to be a short and easy road to riches. But, with the beginning of the fencing period and of settlement, there would be a different state of affairs. It would then be found that there had been scores of appropriations for every acre of land. There would be unending conflicts over boundaries, priority of location, and legality of notice. There would be lawsuits in court and physical contests outside.

The settlement of these titles would cost more than the value of the land, and there could be no assurance of a just or final settlement at any time or at any cost. To the majority of appropriators such a land system would be a calamity, while by those wishing to settle on and improve this domain it would be regarded as a senseless surrender of public property and a wanton sacrifice of public interests.

In every State which makes water personal property, and thus places a premium on the effort to acquire speculative or extravagant rights, litigation begins as soon as an attempt is made to enforce these rights. No matter what the law may be, every man who has created a home by changing an arid plain into a fruitful field believes he is entitled to the free use of the water by which this seeming miracle is wrought, and, if compelled to purchase this from some one who, after receiving it as a free gift, constitutes himself a bar to progress and a legal parasite on actual tillers of the soil, resents such compulsion as a moral wrong.

In detail, each irrigation code is sufficient unto itself. The causes

of litigation are not, therefore, the same in all arid States. A few illustrations will be given to show the nature of these differences. They are taken from States where irrigation has reached its greatest development rather than from those conspicuous for their abuses.

California stands first among the arid commonwealths in the cost and perfection of ditches, and in the skill and economy with which water is used. It also leads in the number and cost of water-right litigations. Water in that State is personal property. Those who do not want to appropriate it for use can appropriate it to rent or sell. There is no limitation on the volume which may thus be claimed. Water rights are located exactly as mining claims are, and the records of appropriations from a single stream, instead of being filed in one place, are divided between the several counties through which the river or its tributaries may flow. There is no special tribunal for the adjustment of these conflicting appropriations, or system of administration when rights are once determined. There are extravagant rights acquired by appropriation, indefinite rights of riparian proprietors, and unknown rights based on Spanish and Mexican grants. Making of water personal property and recognizing its appropriation for the purpose of sale has made it a speculative commodity. It is largely owned apart from the land, and the tiller of the soil is at the mercy of the owner of the stream.

I recently learned of a case where the litigation over a water right had occupied the courts for seven years. It stopped because the litigants were unable longer to pay lawyers' fees; but one of them informs me that, as soon as he can afford it, he will renew the contest. A single riparian proprietor has compelled the users of the stream on which he lives to pay him $250,000 for his consent to their using it. The users of water from Kings river have, all in all, paid hundreds of thousands of dollars to the riparian and other appropriators of that stream for the right to use its waters. Nor is their title thereto as yet secure. There are yet unused lands along that stream, and the riparian proprietors of these lands have a prior right to divert its waters.

In Utah, as in California, irrigation practice is immeasurably superior to irrigation law. Irrigated agriculture is the leading industry of the State, yet in no commonwealth is there greater uncertainty over titles to water. The comparative immunity from litigation which this State enjoys is not due to the excellence of its laws, but to the admirable influence of the Mormon church in promoting the peaceful settlement of controversies. In Utah, as in California, water is personal property. The appropriator who receives it as a free grant can, if he does not desire to use it, compel some one who does to pay him

for the privilege of doing so. The laws which define rights and the provisions for determining these rights are inadequate. Priorities and amounts of appropriations have been in the past determined by the selectmen of each county, and, as streams often pass through several counties, there may be several sets of priorities and as many appropriations of the same supply. Until last year the State had no central bureau of administration, or even a State engineer, and the law which created this office made no provision for paying the salary of the man who fills it.

Colorado was the first State to provide for the supervision of streams. The administrative features of this law are admirable, and are the basis of the laws of several other States. Colorado has also been fortunate in her State engineers. They have all been earnest, conscientious officers, and several have been men of wide experience and great ability in their profession. The success which has attended the operation of the Colorado irrigation code has been largely due to the practical knowledge of the water commissioners and the tact and ability of the State engineers. They have had to deal, however, with defective titles to water. In this State, as in the two before referred to, the practice of irrigators is superior to the code which governs them. The fundamental weakness of the Colorado law lies in delaying public control of streams until after their waters have been disposed of.

Although the State engineer is the head of the irrigation system, he has no control whatever over the location of canals, or the character of the appropriation which govern the volume they may divert. The man best fitted to protect public interests has no voice in the disposal of this form of public property. Water rights are established by a clumsy, illogical, and expensive adjudication in court. The questions which should govern these rights are physical rather than legal, and it is no part of the training of a judge to know what a canal will carry, or what are the usages of irrigation. The adjudication of these rights under the Colorado law is simply a contest among those who have rights to establish. There is no State investigation of the necessities of irrigators, or of the truthfulness of the claims filed. If the interested parties agree among themselves to submit extravagant or fraudulent claims, they are usually successful. Such agreements are of frequent occurrence. They were the rule rather than the exception in all the early adjudications. As a result, the early decrees disposed of many times the stream's volume.

In 1884 and 1885, while acting as assistant State engineer of Colorado, I measured the ditches of northern Colorado on the streams which had been previously adjudicated. In my report of these measurements

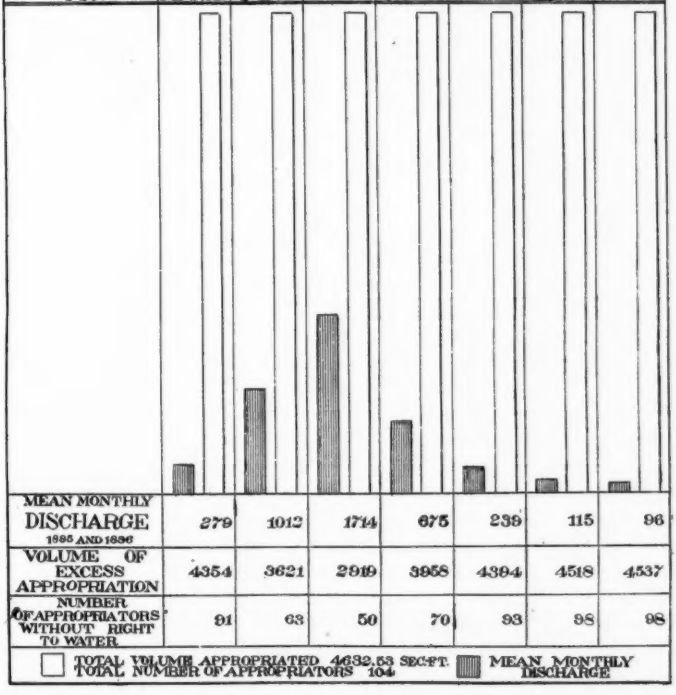
I called attention to the discrepancy between the decreed appropriations and the actual carrying-capacity of these ditches and canals, in the following terms:

"So great was this in some instances that the result of the gagings and the decreed capacity seem to have no connection with each other. Ditches were met with having decreed capacities of two, three, and even five times the volume they were capable of carrying, ever have carried, or will probably ever need. Other ditches in the same district have decrees which fairly represent their actual needs. It needs no argument to show the worse than uselessness of these decrees as a guide to the water commissioner in the performance of his duties."

When these decrees were rendered, the majority of appropriators believed that rights for irrigation were limited to the lands already irrigated, and that, so long as used there, the actual volume stated in the decree cut very little figure. Hence, there was little solicitude on the part of late appropriators as to any danger arising out of excessive grants. Under the terms of these decrees each appropriator is entitled to a definite volume of water described in cubic feet per second, and to a continuous flow of this volume throughout the year.

Recent decisions of the Colorado supreme court have made water personal property, and recognized the right of the holders of these decreed rights to sell the entire volume granted. As a result, the owners of earlier rights are enlarging their ditches and extending them to water other lands, or, where this is not possible, are selling the surplus to other users. In this way water is being taken away from land long cultivated, and used to reclaim new land. Every attempt to do this, however, is contested. The truth is that irrigators have, in practice, been building up a system on one theory of water rights, while the courts have formulated a system based on another theory. They have now reached a point where one of the two must give way. If the doctrine laid down in the decisions of the Colorado supreme court are carried to their logical conclusion, it will transfer the ownership of a majority of the streams of northern Colorado to a few early appropriators, and compel a large proportion of the actual users of water to purchase from such owners the water they have heretofore had for nothing. That this is not an extreme statement is shown by the accompanying diagrams, which exhibit the relation between the mean monthly discharge and the decreed appropriations of the Poudre river and Boulder creek, two important streams of northern Colorado. The mean discharge of the Poudre, as given, was determined by taking an average of the mean monthly discharges for each month of the irrigation season for the years from 1890 to 1894 inclusive. It will be seen that, even in the month of

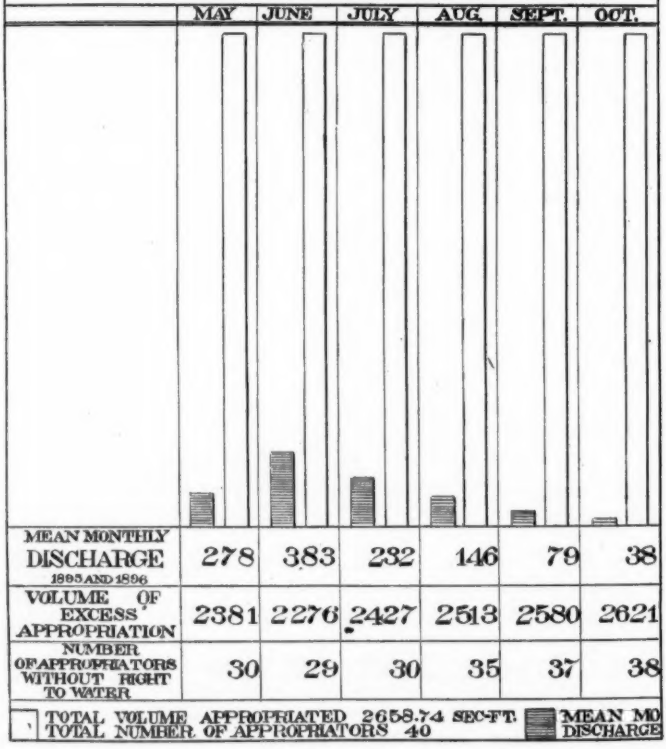
DIAGRAM
SHOWING THE RELATION BETWEEN THE MEAN MONTHLY DISCHARGE OF THE POUDRE RIVER AND THE APPROPRIATIONS THEREFROM



greatest discharge, it is less than one-half the total volume of the appropriations, and that in two months of the irrigation season 98 of the 104 appropriators have no legal right to water. This is true only in case the doctrine of absolute ownership of the decreed volume shall be fully sustained. Thus far later appropriators have been able to use water, because no attempt has been made to enforce such right.

On Boulder creek the extravagant character of these decrees is even more strikingly exhibited. The mean monthly discharge for June, as shown by the State engineer's report, for the irrigation seasons of 1895 and 1896, was 383 second-feet; for October, 38 second-feet. The decreed appropriations are 2,659 second-feet. There are

DIAGRAM
SHOWING THE RELATION BETWEEN THE MEAN MONTHLY DISCHARGE OF BOULDER CREEK AND THE APPROPRIATIONS THEREFROM



forty appropriators, and, from the earliest to the latest, all have been using water to the full extent of their needs during a considerable part of each season, and, except in years of unusual scarcity, during the entire season; but this is because those having decreed rights have not utilized them.

When the stream carries one-third the decreed volume, water runs to waste under present conditions. But, if these surplus amounts are to be treated as personal property, they will, in time, be sold, and, when

they are, about half of the users will have to buy a new right in flood-time, and more than three-fourths will have to look to the early priorities for permission to use water during the remainder of the season. The persons who will buy this water have been actual users of it for years. They will purchase it from those who have never used it at all, and whose sole claim to its possession is due to a defective procedure and an erroneous decision of the court in determining these rights. Whether or not such a state of affairs will ever come to pass cannot be foretold, but it is certainly true that the holders of these rights are working to bring it about. If the decrees are valid, they will in time be enforced; if not, they ought one and all to be set aside. Thus far every attempt to enforce these surplus rights has resulted in litigation. The records of the supreme court of Colorado are burdened by appeal after appeal growing out of these excessive grants, and this will continue until either the entire system has been declared unconstitutional or late appropriators recognize that there is no hope of relief.

The management and disposal of streams is the greatest economic problem of the western half of the United States. On its solution depend the ultimate population and wealth of that region. It ought to represent the best thought and experience of the times. Instead of this, some of the laws now in force are a disgrace to a self-governing people. The history of other irrigated lands shows that certain institutions are necessary to the best results. Among these are the perpetual public ownership of streams, the limitations of rights to water to the right of use, and the restriction of this right to the place and purpose where originally acquired. Rights to water for irrigation should inhere in the land reclaimed, and be inseparable therefrom.

The efficient supervision of streams and just determination of rights to water require an intimate acquaintance with the laws and practices of irrigation. It can be effectively performed only by special tribunals created for that purpose. Courts are not such tribunals. Compelling every appropriator to institute a lawsuit to determine his right to water is a senseless makeshift.

Under a rational system the issuance of a certificate of appropriation is a purely ministerial act. There is nothing judicial about it. There is no more necessity for a court decree to establish a water right than for such a decree to confirm a land patent. Nor do the wisdom and efficiency of these reforms depend on the experience of other irrigated lands. For the past seven years they have been tested in the United States. They are all embodied in the irrigation code of Wyoming, and it is sufficient to say that, during the entire period of

their operation, which had its beginning with the adoption of the State constitution, there has not been a single controversy or abuse due to the limitations imposed. On the contrary, the adoption of these restrictions ended scores of controversies and abuses. The only litigation over water rights which now occupies, or ever has occupied, the attention of the courts of that State or territory has resulted from attempts to establish or enforce surplus or speculative rights in streams.

There are two other provisions in European irrigation laws which, it is believed, will be found worthy of adoption. Under the present American system all appropriations of water are made in perpetuity, the appropriator receiving this as a free grant from the public. The subsequent supervision of the stream to protect this right is paid for by taxes. This is an illogical procedure. The public surrenders valuable property, for which it receives no direct return, and, in doing so, is compelled to shoulder a perpetual burden in the protection of that property. A better system would be to require each user of water to pay the State a rental therefor, these rentals to be very small, intended only to meet the expenses of supervision and prevent the salaries of water commissioners from becoming a burden on the public. A great value of this system would be that it would promote economy. The man who has to pay for what he gets will not be wasteful. It also places the doctrine of public ownership in a form which can be understood by all. That is not true at present. The man who get a free grant to the use of water in perpetuity comes in time to think he owns it, no matter what the laws or constitution may say.

The second change is that appropriations should not be made perpetual. They should be treated as franchises, and their operation restricted to a definite number of years. If rights to water were limited to fifty years, it would meet all the requirements of present development, and would enable the United States in the future to adjust their water laws to changing conditions. The present method may in time prove a serious obstacle to desirable, or even necessary, reforms.

THE ELECTRIC DEVELOPMENT OF HYDRAULIC POWER.

By F. C. Finkle.

A VERY significant movement, in the present age of extensive power applications, is the reversion of interest to the development and utilization of water-power. The statement was recently made in these pages* that the water-powers of Scotland might be made to generate electricity sufficient to operate all the railroads of that country.

Dr. Louis Bell has pointed out† that there are not less than 5,000,000 hydraulic horse power ready to be utilized in the United States when industry calls for it.

The Miesbach–Munich line stands as the pioneer in the necessary concomitant step—electrical transmission, but the demonstration there afforded was hardly complete from a practical view point, and it remained for the installation at Fresno, California, to accomplish the first long-distance commercial transmission. This delivery of electric power at 11,000 volts over a line 35 miles long was an advance of widely-recognized importance; indeed, California is peculiarly fruitful in similar examples—Pomona, San Bernardino, and Sacramento furnishing instances of power and light transmissions over distances varying from 13¾ to 28¾ miles.

This lends a proportionate value to the consideration of other installations in the same region, for, though these precedents of success have naturally their strongest influence in their own immediate neighborhood, the lessons are of very broad application. The last few years have witnessed a very great activity in the development of hydraulic power in the counties of San Bernardino and Los Angeles, the two leading counties of southern California. This activity still continues, and undoubtedly will continue until all the possibilities in this direction have been fully improved.

At first thought it may seem strange that this work should have been carried on to so enormous an extent in southern California at a time when industry was depressed throughout the United States. But, upon reflection, the causes which led to the inauguration and continuance of this movement become perfectly plain.

* Prof. George Forbes, in the Engineering Magazine for October, 1897.
† In The Engineering Magazine for January, 1897.

Southern California, being the principal home of the citrus fruit industry in the United States, is rapidly becoming the region of dense population and small farms, as the high state of cultivation and large profits of orange- and lemon-growing make holdings of from five to ten acres ample for the support of a family. This has caused the rapid growth of cities and towns, where the demand for power for rapid transit and light is imperative, and the thick rural population makes suburban street-car service a necessity.

The following table gives, in round numbers, the population of a few of the principal cities of southern California, showing the phenomenal increase since 1880:

NAME OF CITY.	POPULATION.		
	1880.	1890.	1897.
Los Angeles	11,000	50,000	110,000
San Diego	2,500	16,000	25,000
Pasadena	400	4,800	15,000
San Bernardino	1,700	4,000	10,000
Riverside	1,300	4,900	9,000
Pomona	000	3,600	5,000
Redlands	000	1,900	4,500

In addition to the needs of her own population, southern California has to provide for the convenience and comfort of the army of tourists attracted to her coast and mountain resorts in summer and her interior valleys and cities in winter by the equable climate, beautiful scenery, and great variety of horticultural and floral wonders.

Another feature peculiar to this section is the irrigation problem. The gravity sources of water-supply available for irrigation were exhausted long ago, and, as new areas are brought under cultivation, it becomes necessary to pump water for irrigating them. Power is also required for the small manufacturing and mechanical work carried on in the different cities and towns, as well as for the beet sugar and canaigre industries, which are growing to large proportions.

To generate steam power for these various purposes there is no cheap fuel available, as coal has to be imported from England, costing, when landed, from $6.50 to $9.00 per ton, depending on the quality and on the rate of import duty, while the limited amount of fuel-oil obtained from wells in the vicinity of Los Angeles sells for from $1.00 to $1.50 per barrel, which is equal to good coal at from $4.00 to $6.00 per ton. As a result of these conditions the production of power costs from $70.00 to $100.00 per horse power annually,

which high cost would have caused the development of the water powers much sooner, had it not been for the fact of their location at a considerable distance from the centers of population. As soon as long-distance electrical transmission became an accomplished fact, the remoteness of the water powers from the market was no longer an objection, and this field of development became a most profitable one.

The beginning was made by the construction of a plant in Mill Creek Cañon by the Redlands Electric Light and Power Company in 1893. The head works of this plant are illustrated on page 1017, which shows the upper end of the intake tunnel, and on page 1020, which shows the outlet of the same tunnel into the flume. The remainder of the system consists of about two miles of 36-inch riveted steel pipe having a fall of about 500 feet, the power house (an interior view of which is shown on page 1019), and the transmission lines to Redlands, Highland, Mentone, Colton, Riverside, and other outside points, where power is furnished for lighting, pumping water for irrigation, and operating the plant of the Union Ice Company at Mentone.

The capacity of the Redlands Electric Light and Power Company's plant is 800 h. p. at the lowest stage of the water in Mill creek, and the cost of the system was more than $75,000. It was built from the proceeds of bonds sold, and the revenues from power rentals have been sufficient to pay all expenses of operating and maintaining the plant in the best possible manner, interest and sinking fund for the bonded debt, and regular dividends on the stock.

Contemporaneously with the construction of the Redlands Company's plant the San Antonio Light and Power Company built a small plant in the San Antonio Cañon with a capacity of about 400 h. p. at the lowest stage of water in San Antonio creek. The output of this plant was immediately disposed of for lighting purposes in San Bernardino, Pomona, and Ontario, where a demand considerably in excess of the company's capacity existed, and this venture has proved as profitable as the Redlands enterprise.

The fact that these two undertakings were so successful, even during the financial distress of 1893, 1894, and 1895, coupled with the urgent demand for more power, caused preparations for the speedy development of all other water powers in the vicinity. The result was the organization of the Electric Power Company of Los Angeles, the Southern California Power Company, the Lytle Creek Light and Power Company, and the San Gabriel Electric Company, all of which began operations in the latter part of 1896 or the early part of 1897.

The Electric Power Company owns the upper portion of the water power of the San Gabriel river in Los Angeles county, and the San

Gabriel Electric Company the lower power on the same river. The Southern California Power Company owns the water power of the Santa Ana river, and the Lytle Creek Light and Power Company owns that of Lytle Creek, both of which streams are in San Bernardino county.

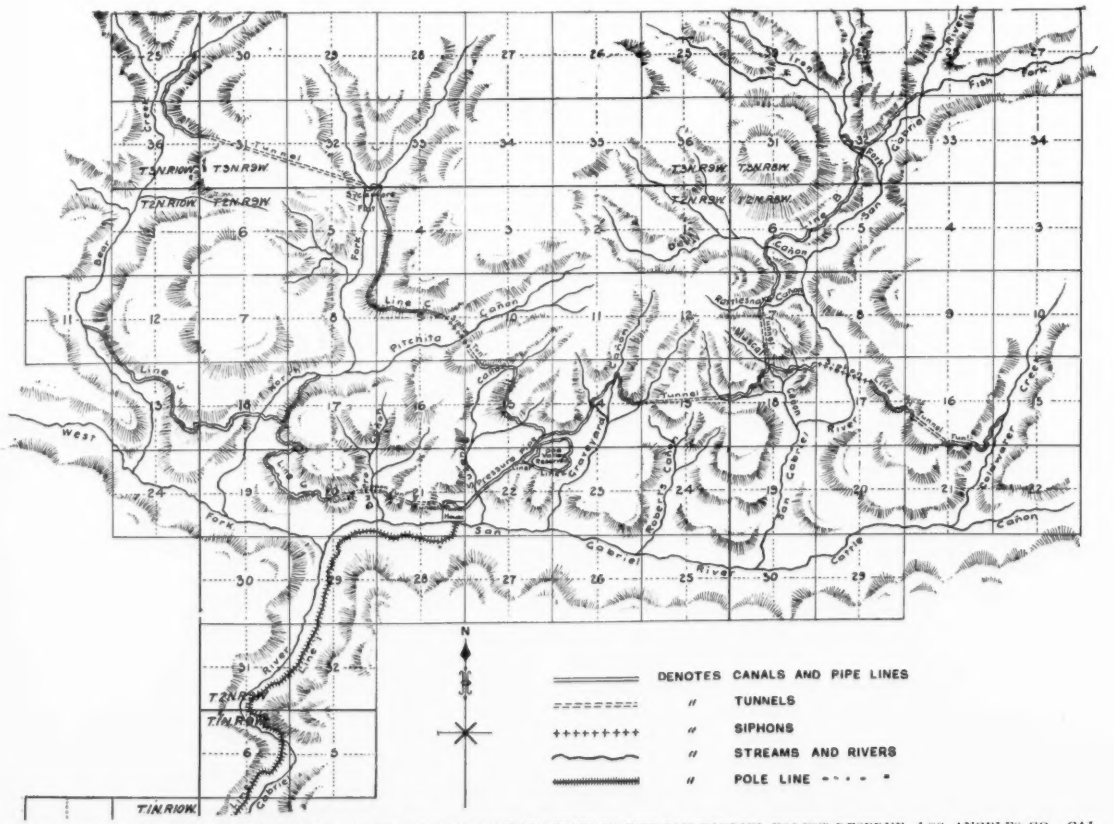
The plants of all these companies are now in course of construction, and at the present rate of progress they will be completed during 1898 or early in 1899. Therefore a brief description of the different projects, and a statement of the cost of each, will prove interesting at the present time. The location of each power and the site of the works in course of construction, together with those of the two powers already built and referred to above, are shown in the map on page 1022.

The Electric Power Company's project is shown on the opposite page in a sketch map taken from the company's right-of-way map across the San Gabriel forest reserve. Line "B" is the canal and aqueduct from the main San Gabriel river, Fish fork, and Iron fork, and will deliver the water of these streams to the head of the pressure pipe line at an elevation of 3,400 feet above sea-level. Line "H" is for a conduit to convey the water of Coldwater creek into the canal on line "B." Line "C" is for a canal and aqueduct from Bear creek and North fork to the head of the pressure pipe at the point of delivery of line "B."

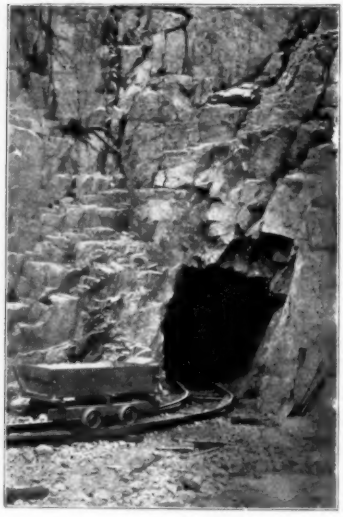
The power house of the installation will be located below this point, on the bank of the river, at an elevation of 1,450 feet above sea-level, thus giving a fall of 1,950 feet for the water from the end of the canals to the power house in a horizontal distance of 7,600 feet. This distance will be covered by a 26-inch steel pressure pipe, through which the water will be delivered to the water motors in the power house under a static pressure of 825 pounds per square inch.

Lines "G" and "J" are for aqueducts to convey the lower waters of Bear creek and North fork to a point above the power house at an elevation of 2,050 feet above sea-level, thus giving a fall of 600 feet through another pressure pipe 14 inches in diameter and 1,300 feet in length.

In order to increase the capacity of the plant, a reservoir will be built at Doe Valley at an elevation of 2,850 feet above sea-level, and a steel pressure pipe laid from it to the power house. This pressure pipe will be 14 inches in diameter and 5,200 feet long, and will deliver the reservoir water to the water motors under a pressure of 600 pounds per square inch. The capacity of Doe Valley reservoir will be 3,418 acre-feet, and it will be filled through the canal on line "B" from the San Gabriel river at times when the flow exceeds the



MAP SHOWING RIGHTS OF WAY ASKED FOR POWER-DEVELOPMENT PURPOSES IN THE SAN GABRIEL FOREST RESERVE, LOS ANGELES CO., CAL.



A TUNNEL PORTAL.
Southern California Power Co.

capacity of the power plant. The gaugings of the river show that there is an abundance of water each year, during the rainy season, for filling many such reservoirs, and it is to be deplored that there are no other reservoir sites within the watershed. Line "I" is the route for a pole line from the power house to the south boundary of the San Gabriel forest reserve, and all the power will be transmitted over this route, from which different transmission lines will branch out to points where the power is to be delivered for use, the principal line being the one to Los Angeles, a distance of 33½ miles from the power house.

The cost of the Electric Power Company's plant will be approximately as follows:

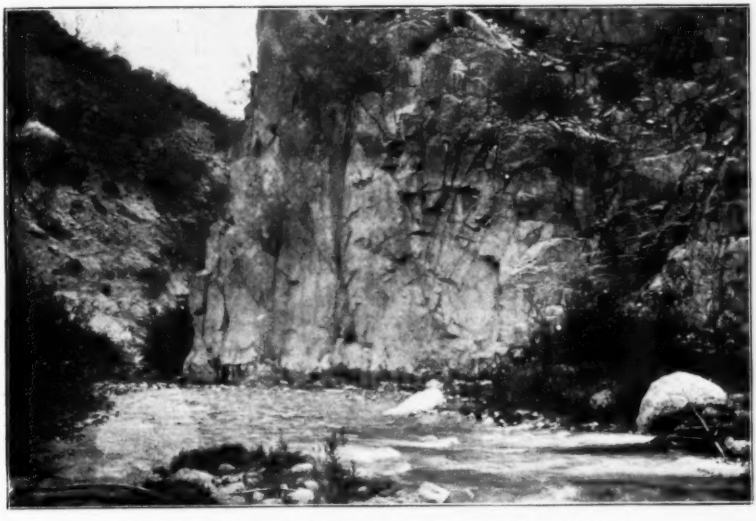
Canal on line "B"	$115,000.00
Three steel pressure pipes	106,000.00
Canal on line "C"	127,000.00
Canals on lines "G" and "J"	27,000.00
Doe Valley reservoir	49,000.00
Power house and generating equipment complete	160,000.00
33½ miles of transmission line	75,000.00
Superintendence, surveys, roads, and incidentals	40,000.00
Total	$699,000.00

The power developed at the lowest stage of the river, using the reservoir only from six to eight hours each day to tide over the heavy load occasioned by street-car and lighting service, will be as follows:

Lines "B" and "C," 3,400-foot level	4,550 H. P.
Lines "G" and "J," 2,050-foot level	550 H. P.
Doe Valley reservoir, 8 hours daily for 160 days	4,000 H. P.
Total	9,100 H. P.

This will be the capacity of the plant, not only during the 160 days when the reservoir is used, but also during the remaining 200

HEADWORKS, REDLANDS ELECTRIC LIGHT AND POWER CO.



LOCATION OF DIVERTING DAM, SOUTHERN CALIFORNIA POWER CO.

days, since the river-flow is then sufficient to create this power without water from the reservoir.

The conduits of the Electric Power Company which do not consist of steel pressure pipes will comprise cemented canals, flumes, tunnels, and cement pipes. The sections on pages 1023-1026, illustrate the plan of these conduits. These plans, showing the manner in which aqueducts, both for power and irrigation, are generally constructed in southern California, are interesting.

At the present writing the Electric Power Company has completed two and one-half miles of the conduits above described, surveyed the lines for all the remainder, and prepared most of the roads and trails necessary to complete the construction of the plant.

LYTLE CREEK AT MILLER'S NARROWS, IN SUMMER.

The Lytle Creek Light and Power Company is preparing to divert Lytle creek at Miller's Narrows, this being the point on the stream where the greatest flow is found in the dry season. A view of the stream at this point during the dry season, or period of low water, is shown by the illustration on this page.

Diversion will be effected by a tunnel through the point, or spur, of the mountain at Miller's Narrows, to tap the stream immediately above the Narrows. This tunnel is now being constructed. From the mouth of this intake tunnel the canal is to be built along the side of the mountain bordering Lytle Creek Cañon on the east. It

POWER-HOUSE OF THE REDLANDS ELECTRIC LIGHT AND POWER COMPANY.

OUTLET OF TUNNEL, AND SANDBOX, REDLANDS, CAL.

will consist of cemented canal, wooden stave pipe, and tunnels, its total length being 20,168 feet to the point, where the water will drop down to the power house, through a 26-inch steel pipe 1,460 feet long, a vertical distance of 500 feet. The location of a considerable portion of the conduit line is shown in the illustration below which is from a photograph taken after the line had been surveyed and the route partly cleared.

In addition to using the ordinary summer flow for power, as above indicated, the company intends to store surplus water in winter by building a dam 90 feet high at Miller's Narrows. Such a dam will impound sufficient water to give a continuous discharge of 14 second-

CANAL LINE OF LYTLE CREEK LIGHT AND POWER CO.

feet for 200 days each year, and there is a large flow during some of the winter months from which the reservoir can easily be filled without depriving the power plant of any of the water required by it during this time. The estimated cost of the system of the Lytle Creek Light and Power Company, without the reservoir, is as follows:

Intake tunnel	$ 1,500.00
Canal to head of pressure pipe	56,000.00
26-inch pressure pipe	8,000.00
Power house and generating equipment complete	32,000.00
Transmission lines	27,000.00
Surveys, superintendence, incidentals, etc.	10,000.00
Total	$144,500.00

SITE OF HEADWORKS, SOUTHERN CALIFORNIA POWER CO.

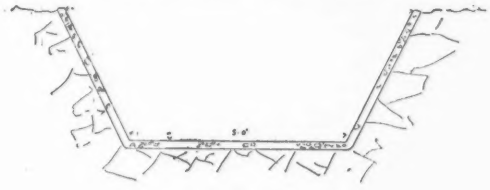
The result of this expenditure, taking the minimum flow of the stream, will be 1,300 h. p. By building the impounding dam at Miller's Narrows the total cost will be increased to $235,000 and the power to 2,050 h. p. The company's intention is to build the works without the reservoir at once, and, as soon as satisfactory contracts to sell the water for irrigation purposes can be obtained, to proceed with the construction of the dam. At present work is being prosecuted on the intake tunnel and the plans and specifications are being prepared for the remainder of the plant.

The intended point of diversion of the Southern California Power Company is on the Santa Ana river at the junction with Bear creek, its principal tributary. This point is shown in the illustration on page 1017, which affords an idea not only of the volume of water available in the stream, but also of the topography of the banks and the surrounding country. The particular site selected in this instance, as will be immediately apparent, is well adapted to the purpose, being narrow, with steep, rocky cliffs on both sides. From here to the head of the pressure pipe a conduit 14,650 feet in length has been located, to consist of 10,780 feet of solid rock tunnel and 3,870 feet of flume. The pressure pipes from the end of this conduit to the power house will be 2,200 feet in length, and will consist of two 30-inch lap-welded steel pipes.

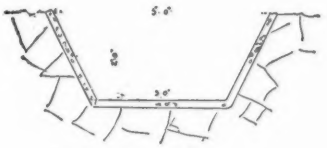
The fall through the pressure pipes from the end of the conduit to the power house is 750 feet, which will give a static pressure of 317 pounds per square inch at the water motors, after deducting for loss due to friction in the pressure pipes.

The water supply for the plant of the Southern California Power Company will be derived from the natural flow of the Santa Ana river and Bear creek and from the water conserved by the famous Bear Valley reservoir, at the head of Bear creek. The water is used for irrigation at Redlands, Highland, Perris, and Allessandro, being diverted from the Santa Ana river below the power house of the company; and the quantity supplied to the places named can never be less than 60 second-feet, according to existing contracts, any deficiency in the stream below this amount being made up from the reservoir. It is estimated, however, that, on account of the various losses occurring while carrying the water long distances, 80 second-feet are necessary at the location of the power company, in order to make the delivery of the 60 feet possible at the points where it is used for irrigation. Hence the minimum supply of the company is placed at 80 second-feet, which insures a marketable power from the plant of 4,500 h. p.

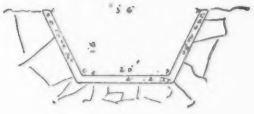
The cost of the Southern California Power Company's plant is estimated at $900,000, including $400,000 already expended for land, franchises, water rights, rights of way, and preliminary work, and $150,000 expended in constructing the conduit and purchasing materials for the plant. The remaining $350,000 will be required for the completion of the conduit, the construction of the two 30 inch pressure pipes,—for which the J. D. Hooker Company, of Los Angeles, already has the contract,—the construction of the power house and supplying it with generating machinery, and the completion of the



Cross Section of Large Canal.

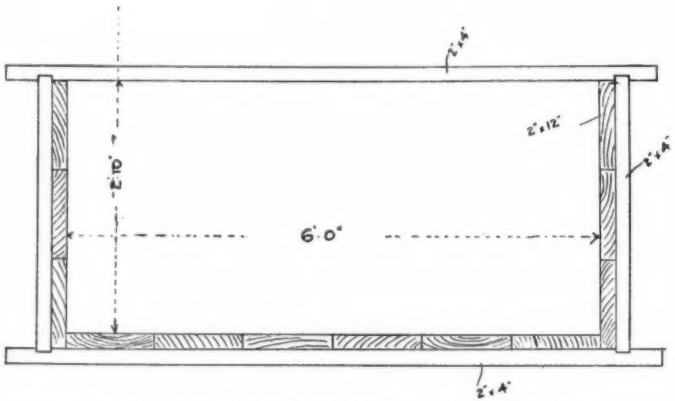


Cross Section of Medium Canals



Cross Section of Small Canal.

DETAILS OF CANALS, ELECTRIC POWER CO. OF LOS ANGELES.



DETAILS OF FLUMES, ELECTRIC POWER CO. OF LOS ANGELES.

transmission lines with the necessary step-up and step-down current transformers.

The construction of this plant is well under way at the present time, nearly half the work having been completed, and, as the company has contracts calling for the delivery of power June 1, 1898, it is to be presumed that the system will be in operation by that time.

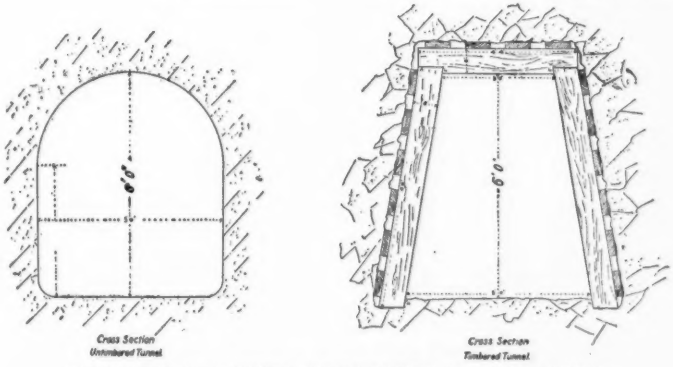
The intake of the San Gabriel Electric Company is on the San Gabriel river, about three miles below the power house site of the Electric Power Company of Los Angeles, and at an elevation of 1,150 feet above sea-level. The rights to the intervening fall of 300 feet belong to the latter company, and a supplementary plant will be constructed to utilize it, as soon as the larger one, already described, has been completed.

The San Gabriel Company's intake is by means of a tunnel or subterranean gallery, which will tap the river about 18 feet below the stream bed ; and it is also planned to build a submerged dam to force up any underflow which may exist at this point. From the outlet of the intake tunnel the conduit will traverse the side of the mountain along the south-easterly bank of the river, gradually rising above the stream, until the mouth of the San Gabriel Cañon is reached, where a drop of 400 feet is obtained. The power house will be located at the foot of this drop, and the water conducted down into it from the end of the conduit through a 36-inch pressure pipe. The conduit from the intake to the head of the pressure pipe will be about seven miles long, over four miles of it being tunnel and the remainder 48-inch wooden stave pipe. The tunnels will be lined with cement

throughout, and the pipes will be made of 2-inch California redwood lumber and banded with ¾-inch round steel hoops.

The company has let the contracts for the completion of the plant, and the work is about half finished at this writing. The contract prices have not been made public, but the approximate cost will be as follows:

Intake tunnel	$ 15,000.00
Submerged dam	10,000.00
Conduit and pressure pipe	150,000.00
Power house and generating equipment	40,000.00
Transmission lines	40,000.00
Surveys, superintendence, and incidentals	20,000.00
Total	$275,000.00



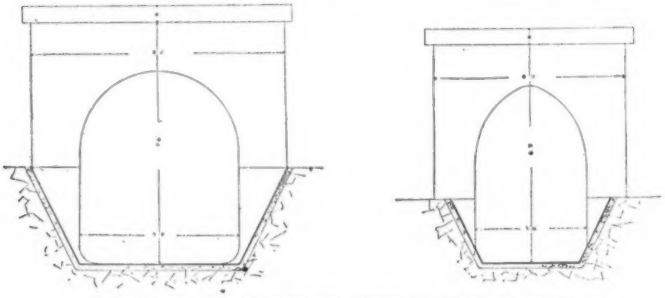
DETAILS OF LARGE TUNNELS, ELECTRIC POWER CO. OF LOS ANGELES.

The San Gabriel Electric Company possesses the right to use only the normal flow of the river at *its* point of diversion. The stored and salvage waters of the Electric Power Company, of Los Angeles, being the exclusive property of that company, will be carried out of the cañon over a route of its own, and sold for irrigation. The minimum flow of the San Gabriel river, as reported by the hydrographic division of the United States geological survey in 1896, was 10 second-feet below the intake of the San Gabriel Company. This makes the capacity of the company's plant about 500 theoretical h. p., or about 350 marketable h. p. The company is building its plant of a much larger capacity, however, which indicates that it intends to develop a greater power during a portion of the year, when the flow of the river is above the minimum.

This completes the list of water powers now incorporated and in

course of construction in southern California. Surveys are now being made for other projects on the Whitewater river, the Santa Ana river above the Southern California Power Company's location, and Mill creek above the plant of the Redlands Electric Light and Power Company. If surveys and estimates shall demonstrate that these are practicable, in spite of their greater distance from the market and the greater inaccessibility of the country where they are projected, they will, without doubt, be constructed, as the plants now in course of construction will not be able to satisfy the demand for power in southern California.

Meanwhile engineers will be interested in seeing the powers now under way put into operation, on account of the interesting features



DETAILS OF PORTALS, ELECTRIC POWER CO. OF LOS ANGELES.

embraced by some of them. The great pressure at the water motors —825 pounds per square inch—will make the plant of the Electric Power Company of Los Angeles a notable one, when completed, and the long transmission of the Southern California Power Company—about 80 miles with a voltage of 33,000—will be something decidedly novel, as the longest commercial electric-power transmission at the present time is that of 35 miles at Fresno, California.

In this connection it may be stated that the climate of southern California, on account of its extreme dryness and freedom from electrical storms, is well adapted to long electrical transmissions by means of high voltages.

REVIEW OF THE ENGINEERING PRESS

Breakwater Construction.

A PAPER recently read before the Engineers' Club of Philadelphia by Mr. Louis Y. Schermerhorn contains much valuable information regarding breakwaters on the American coast in particular, as well as some general facts regarding wave-power and the effect of ice and water-pressure upon such structures.

A distinction must be clearly made between breakwaters and jetties, piers, and other similar structures, a breakwater differing from the other constructions in that it is essentially a wave-breaker, intended to resist and check wave-action and provide a protected harbor or roadstead.

In Mr. Schermerhorn's paper especial attention is given to the Delaware breakwater, because it has served as the prototype of all other accomplished or proposed random-stone breakwater construction on the coast of the United States.

Experience upon American breakwaters has determined that the depth to which energetic wave-action extends is about twelve or fifteen feet, and this depth is generally assumed as the approximate plane of rest for the material used. The increased exposure of European breakwaters, and the height of ocean waves impressed upon their works, lowers the plane of rest to a depth of about twenty feet, and the necessary allowance for the incrested tidal range also affects the practice in Europe, rendering the precedents there obtained unsuited for American work.

The term plane of rest is not intended to imply that there is a well-defined line below which no wave-action extends; it rather indicates a depth at which the disturbing effect of the waves has been so reduced that it is no longer able to move the special stones constituting the slopes at that depth.

The slopes of a random-stone breakwater may be divided into: (1) that part of the sea face which is below the plane of rest; (2) that part which is between the plane of rest and the surface of the water; and (3) the part above the surface of the water. On the harbor side only two divisions need consideration,—that below and that above the water surface. Below the plane of rest the slope becomes practically that of the angle of repose of the material between the plane of rest and the surface of the water the slope will be formed by wave-action, modified by the dimensions of the stone; while above the surface of the water the slopes on either side will be artificial, and will depend upon the nature of construction employed.

The flattest slopes on the sea-side of the Delaware breakwater are about 1 on 3, which is much steeper than is used in Europe, the active sea slopes of the Portland, Plymouth, and Cherbourg breakwaters varying from 1 on 4 to 1 on 8; while the Delaware breakwater is not exposed to the force of seas such as are thrown upon the European works, it is probable that its slopes are more nearly in equilibrium with the forces impressed upon them than are those in the flatter designs.

Since the maximum economy in construction is obtained when the slopes and cross-section are such as to produce equilibrium with the external forces, it is possible to adopt such a method of construction as will cause the slopes to be determined experimentally in each case, by following a certain order of procedure.

To accomplish this result the random stone is first deposited in an area conforming strictly to the space selected for the assumed plane of rest, the material thus being forced to assume the steeper angle of repose belonging to this portion of the work. The second section, consisting of the mass between the plane of rest and the base of the superstructure, is carefully deposited within the area of the base of the superstructure, putting the larger stone on the sea-side, and, as this portion is within the influence of the dis-

turbing action of the waves, it naturally assumes such slopes as place it in actual equilibrium with the wave forces impressed upon it. If, for any reason, too steep slopes have been assumed, the action of the sea corrects the error. After thorough settling has occurred, the superstructure may then be built in any desired manner, usually in the form of a rough, heavy wall built of large stone, bonded together from each side, with the space between filled with smaller material.

This method, which has been developed and applied by Major C. W. Raymond, U. S. A., is that adopted in the new Delaware breakwater, and is also proposed for the new breakwater to be constructed at San Pedro, in southern California.

Mr. Schermerhorn's paper contains much interesting information upon the force and height of waves, gathered from various sources. In the British seas the maximum heights range from 27 to 30 feet; in mid-Atlantic as high as 43 feet; while at Cape Horn waves as high as 50 feet have been observed. The pressures, as measured by marine dynamometers, have reached 6,000 pounds per square foot in the North Atlantic, and 3,000 pounds in the German ocean, while from the effects produced in the destruction of the beacon at the mouth of the Loire it is estimated that the pressures per square foot there ranged between 4,800 and 6,000 pounds. These figures, however, give but little information as to the force of impact, this varying as the cube of the height of the waves; but it has been computed that for waves 15 feet high the energy of impact for each foot in length of wave crest is about 21,000 foot-pounds, and, under certain conditions, much more.

From such considerations, and from comparison with existing works which have stood the force of the sea successfully, the general dimensions of a proposed section can be deduced, after which the method above given, modified in connection with local conditions and materials, may be employed with confidence in the important and difficult work of breakwater design.

The Engineer in the Navy.

THE "line and staff" dispute, which has been pending so long in the United States Navy seems likely to find its permanent solution in the arrangement originally due very largely to Professor Hollis, and included in the report of the Naval Personnel Board submitted by Assistant Secretary of the Navy Theodore Roosevelt.

The substance of the arrangement recommended in this report is that both the line and the staff officer are to be wiped out of existence, as such, and that a new corps is to be substituted, consisting of men who are both sailors and engineers combined.

While this is apparently a graceful way of yielding to the demands of the staff officers for positive rank and an undivided responsibility, and certainly lets the advocates of the inherent superiority of the line down quite easily, it is really a change, the magnitude and importance of which is hardly realized by some who have commented upon it; least of all by the line officers themselves.

When we consider the great changes and advances which have been made in the construction and handling of the modern ship of war during the past few years and the transformation which has been made from the old time vessel into the present fighting machine we must be prepared to see as a result of the adoption of the report of the Naval Personnel Board that in a few years the officers of the United States Navy will all be engineers, possessing indeed such a knowledge of navigation as is needed for practical use, but above all men familiar with and devoted to engineering as applied to naval warfare, and altogether freed from the fetish of unnecessary official etiquette which has been so much in evidence in the past.

That some such solution of the problem must come, we foreshadowed in these columns several years ago, and it will not be out of place to quote at the present time what was then written upon this subject.

"A modern warship is probably the greatest aggregation of the work of the engineer which can be found anywhere

within the same limits of space, and surely methods of organization and discipline should keep pace with the transformations in construction and operation. A fighting machine must be *fought* by engineers as well as built by engineers, and it may be that the officers of the line will awake to the realization of their false position only to find that there is no further occasion for their existence at all."

Humidity in House-Heating.

ONE of the noticeable features of American houses to those foreigners who chance to be in the United States in winter is the high temperature which is thought necessary in dwellings and public buildings, and with this the excessive dryness of the air is also a matter of observation and comment.

The injurious effects of this dryness, and the relation which it bears to the important subjects of warming and ventilation, form the subject of a paper recently read before the American Public Health Association by Dr. Henry Barnes, and abstracted in *Heating and Ventilation.*

Except in certain localities noted for their dry climate, the mean relative humidity of the air in the United States lies between 60 and 70 per cent., according to the well-known meteorological scale in which zero means entire absence of moisture and 100 corresponds to complete saturation. This proportion of moisture is, in general, better adapted for comfort and health than either a higher or lower degree of humidity, and, if such a percentage were maintained indoors during the winter, it would doubtless be much better for all concerned than the practice of supplying large volumes of hot dry air, or the presence in the rooms of extensive surfaces of heated metal.

From a number of tests of the air in various buildings, heated by steam, hot air, and hot water, the mean relative humidity was found to be only about 31 per cent., while at the same time that of the outside air averaged more than 70, this difference being entirely due to the fact that with the heating no attempt had been made to supply the additional moisture required to maintain the relative humidity at the higher temperature.

The action of such dry air upon any object containing moisture, such as the human body, is clearly shown by exposing a wet-bulb thermometer to the air. The avidity with which the dry air absorbs the moisture causes the mercury to fall very rapidly, and maintains it at a temperature of nearly 20° F. lower than that indicated by the dry-bulb thermometer. It is this refrigeration, due to the rapid and continuous evaporation from all parts of the body, which produces the chilly sensation at the slightest draft or current of air in the hot, but dry, rooms of many houses; while, if the normal degree of moisture were present, the temperature indicated by the ordinary dry-bulb thermometer would also be the sensible temperature perceived by the occupants.

Dr. Barnes shows how inadequate the ordinary methods for supplying moisture are, even when used, and it is far more frequently the case to find that the water-pans and evaporators attached to the hot-air furnaces are not used at all. In some cases a pan of water is placed on a radiator, or a porous pot hung in front of a register, but such cases are the exception, and it is the rule in American houses to ignore the matter almost altogether, and let the air become as dry as the heat will make it.

By computing the volume of air passing through an ordinary hot-air furnace, Dr. Barnes shows that the ordinary methods of supplying moisture are by no means equal to the demand, as nearly fifty gallons of water should be supplied to a furnace in twenty-four hours to maintain the relative humidity at 65. He describes a simple arrangement of metal box containing suspended sheets of cotton-felting with the lower edges dipped in water, furnishing about ten square feet of evaporating surface, and this placed so that the hot air passed through it keeps the humidity in the room at about 53, and makes a temperature of 65° F. comfortable.

There is little doubt that the maintenance of the proper degree of humidity would prevent much of the illness preva-

lent in winter, especially colds, coughs, and throat troubles, and it is very probable that the catarrhal affections so common in winter, and the frequent failure of the vocal organs, may also be the result of the parching effect produced by breathing an excessively dry air.

As many new buildings are now provided with complete ventilating systems in connection with the warming apparatus, it is not unlikely that some form of humidifier may be also attached, which will maintain the correct relative degree of humidity, and thus preserve both the health of the occupants and the joints of the furniture from the injurious action of the parched air.

Compressed Air Explosions.

SEVERAL months ago some account was given in these columns of serious, and even fatal, explosions of mingled air and vapor of lubricating oil in air-compressors in Germany, and now, in an interesting communication to the *American Machinist*, a correspondent describes some similar explosions which have occurred in the United States. Two of the explosions described took place under circumstances that prevented their exact conditions from being observed with much accuracy; as the writer remarks: "For the succeeding few seconds we were all too busy dodging trapdoors and parts of machines with which the atmosphere was filled to take accurate observations; so the cause remained a mystery until the third explosion."

This third explosion occurred in a stretch of horizontal pipe, at each end of which there was a short vertical riser, the whole forming a portion of a connection from a reservoir of compressed air to a point of utilization. This arrangement of piping formed a sort of trap in which any liquid would collect, and, when a valve at the end nearest the reservoir was suddenly opened, admitting a pressure of about 1,700 pounds, a frightful explosion took place. In the words of the writer: "It was much louder than the air explosions which I had previously heard, being sharper and more deafening in character. It was, moreover, accompanied by a great burst of flame, which, together with the concussion, left one dazed for a minute or more."

As these pipes had been tested to 6,000 pounds and had been in daily use at over 2,000 pounds' pressure, it was certainly a higher pressure than the 1,700 pounds in the reservoir which caused the disaster, and the presence of the flame, and the deposit of soot which was afterwards found on the ruptured portion, indicated the nature of the explosion very clearly.

The writer of the communication explains the cause of the explosion in a lucid and practical manner.

"We had two closed valves connected by a loop of pipe containing oil and air at atmospheric pressure. One valve is opened, letting high-pressure cool air into the space. The incoming air stirs up the oil, catches it in the narrow pipe, and drives it, like a plunger, down the tube. The air originally contained in the pipe is compressed by the incoming air, just as if it were acted upon by a piston. Its temperature is almost instantly raised to that corresponding to a red heat or above. The small amount of oil present is vaporized and fired as prettily as though Messrs. Hornsby & Ackroyd had superintended the performance."

The conditions which exist in cases like these are not always as accurately observed or as well described, but there is no doubt that the presence of oil, either in the form of vapor or of finely-divided spray, may become a source of danger in compressed-air plants, and this too, not only in the compressor itself, but also in the connections. That such dangers may be avoided by care both in designing and operating the plant is apparent, and one reason for giving the conditions of such explosions wide publicity is to aid in the avoidance of their repetition.

In this connection there is one important feature which must not be overlooked. Increased pressure usually lowers the temperature of ignition or explosion of a gas or gaseous mixture, so that a mixture which would be exceedingly difficult of ignition at atmospheric pressure will explode under pressure at a much lower

heat. This is clearly shown in the case of acetylene, which is difficult of explosion at pressures below two atmospheres, but which may readily be made to explode at higher pressures.

At pressures of ten or twelve atmospheres the increased ease of ignition is one of the factors that must be considered, and additional care is necessary in cooling all parts of the apparatus; while the use of a minimum quantity of oil and a thorough draining of all parts are features which should not be neglected.

Tests of Cast-Iron Columns.

A VERY important series of tests of cast-iron columns has recently been completed at Phœnixville, Pa., by the department of buildings of New York city, and from an extensive account given in *Engineering News* we make some abstracts.

Three sets of columns were tested to destruction in the hydraulic testing machine of the Phœnix Bridge Company, these being respectively 15 feet 10¼ inches long by 15 inches in diameter; 13 feet 4 inches long by 8 inches in diameter; and 10 feet long by 6 inches in diameter; the thicknesses varying from 1 11-16 inches to ⅝ of an inch. In the first group were two columns taken from the "Ireland Building," which collapsed in the summer of 1895. in New York, and four similar ones cast for the purpose of the test, while the second and third groups each consisted of two columns of kinds used in regular building construction, made by well known firms, and were fair samples, coming within the provisions of the law.

The data of the tests are tabulated in the paper referred to, and some of the salient features may be especially noted. With but two exceptions the thickness varied materially in different portions of the same column, so that in one instance the metal on one side was 1¼ inches thick, and on the other only ⅝ of an inch; and, although this was an extreme case, there was a decided irregularity of thickness, which probably affected the strength materially. All of the 15-inch columns were broken, except one, which was nearly uniform in thickness, and which remained intact at the maximum pressure of the testing machine,—a load of more than 2,082,000 pounds, or more than 40,000 pounds per square inch of area. The breaking load of the others of this group varied from 25,000 to 30,000 pounds per square inch, the variations being apparently due to the presence of cinder, foundry dirt, chaplets, and blow-holes. The smaller columns were all broken with loads ranging from 22,000 to 32,000 pounds per square inch of area.

According to the building law of the city of New York, the strength of all columns and posts is to be computed by Gorden's formula, using a coefficient of 80,000, and a factor of safety of five for cast iron. The application of Gordon's formula, under these conditions, to the columns tested shows that the 15-inch columns should have a breaking strength of 57,000 pounds per square inch, instead of which it actually ranged from 25,000 to 40,000 pounds; while for the 6- and 8-inch columns the breaking strength by the formula should be 40,000 pounds per square inch, instead of 32,000 to 22,000 pounds, as shown by the tests.

Had these columns, therefore, been loaded as heavily as the law permits, the factor of safety in some cases would have been only a little more than 2, instead of 5 as intended. Judging from the physical description given of the columns tested, this discrepancy is much more likely to be due to the defects in the castings than to the inaccuracy of the formula, and apparently a requirement for better material and more-carefully-made castings would raise the strength nearly, if not quite, to that indicated by computation.

An interesting feature of the paper is the description of the calibration of the Phœnixville testing machine by comparison with the Emery testing machine in the United States Arsenal at Watertown, Mass. This calibration was effected by testing a special soft-steel Phœnix column, first at Watertown and then at Phœnixville, using a roller extensimeter reading to 0.0001 inch, the conditions being reproduced as nearly as possible in the

second test, and the same extensimeter being used. The result showed the gage readings of the Phœnix machine to be from 15 to 17 per cent. higher than the actual values, this being due to friction of the machine and possibly to gage error. By using this correction, the tests at Phœnixville are made comparable with those at Watertown, with a possible error of about 3 per cent.

New York Building Laws.

IN several recent issues of the *Engineering Record* the weak points in the New York building law are pointed out, and the subject illustrates very well how the growth of a city and the introduction of new methods may render many points in once adequate ordinances quite obsolete or insufficient. When the existing building laws were enacted, the system of constructing business buildings was altogether different from that now in use. The limit of height was five to six stories; light brick walls, timber columns and floors, and moderate loads were the rule; the modern tall building, with its steel skeleton and deep foundations, was unknown, and any attempt to regulate the practice in modern building work by rules based upon the older conditions must necessarily be defective.

It is doubtless true that the modern great buildings of New York are well designed and properly-built, not because the ordinances have required proper work, but because the engineers and architects in charge have attended to it on their own and their client's account. This, however, is not a good state of affairs, and should not be depended upon.

"Good architects, good engineers and good builders have in many cases done what the building ordinance has failed to require them to do; but that is not enough. Well-intentioned men are sometimes not well qualified to do those things which they may desire to do, and such things as indifferent and careless, not to say unscrupulous, building are not unknown."

Most of the criticisms of the building ordinance of New York are naturally made on the score of omission,—a thing to be expected when the practice has outgrown the legislation,—and a few of these defective features are worthy of mention. In the question of the quality of materials employed, vague terms, such as "the best material, made in the best manner," should be replaced by specific terms of precise, legal, and scientific meaning, about which no difference of opinion could exist. The methods of testing and describing materials of construction are well enough known to permit of accurate specification, and materials of lower grades could be clearly specified as permissible for those purposes for which they are fitted, and no hardship wrought and no danger incurred. The present law includes some attempts to use scientific formulas for certain limited purposes, but so indefinitely as to permit almost any proportions to be deduced.

Working stresses permitted on iron steel, masonry, timbers, etc., need careful revision and extension, in accordance with the advance of knowledge concerning the behavior of the materials and the changed conditions under which they are used. Some valuable materials, which are now practically excluded, because of the omission to provide load factors, should be included, and altogether a much broader scope for materials to be used is desirable, and, with proper provision for test requirements, would be perfectly safe.

These are but a few of the important points which have been advanced to show the weak points of the present antiquated law, and the urgent need for proper revision. That this revision should be made with the assistance and advice of competent engineering specialists is evident.

"The work of revision of the structural features of the building law should be put into the hands of a small committee of experts in structural matters whose broad experience in engineering and architecture, and whose character as reasonable men, would insure a comprehensive, safe, and thorough treatment of every feature of the whole matter, so that a building law truly worthy of the greater New York would be secured."

The Gas Engine and its Mission.

UNDER the above title Professor Sidney A. Reeve has written a series of papers for the *Railroad Gazette* which contains much that is valuable and important, and while we can hardly endorse all of the points made, yet we feel sure that the ultimate success of the internal combustion motor as a commercially valuable source of power will depend very largely upon the way in which Professor Reeve's criticisms are met in actual construction.

After reviewing the existing forms of construction and showing that by far the great majority of gas engines in actual service are of the Beau de Rochas, or "Otto" cycle, governed by missed impulses and igniting by electric spark or by hot tube, the writer goes on to show that at the present time the gas engine must still be regarded as a motor for small powers. The average output of gas engines in the United States during the past five years has been about 20,000 h. p., the average size of engine running between 5 and 15 h. p. During the last year or two, however, this average size has increased very perceptibly and is still rising rapidly. Nearly all builders are now offering engines of 30 to 40 h. p. A few more have attained a size of 100 h. p., while two houses offer engines as large as 250 h. p., as nearly ready for the market, although they have none actually running.

The high economy of the gas engine when operated with fuel gas, and the placing upon the market of satisfactory gas producers, renders such motors far more efficient than the steam engine; and yet the replacement of the steam engine by the gas motor does not take place with that readiness which might have been expected from such a gain in economy. Several reasons may be advanced for the slowness of the introduction of the gas engine for purposes of general motive power in addition to the comparatively recent production of motors as large as 100 h. p., and the slow improvement in the gas producer.

"The real explanation lies in the fact that the gas engine, as a machine, cannot be paralleled with the steam engine. It is in no disparagement of the splendid work done in the development of the engine, nor in anything but faith in the future of the engine, that this fact is pointed out as the most significant one in the whole gas power question.

To be specific, attention should be centred upon the nature of the motor cycle. First there is no storage of power anywhere except in the moving fly-wheels; secondly, the source of power is not only an explosion—abrupt and excessive in its vigor—but is an explosion which rigidly refuses to be efficient under any except narrowly specified conditions. Finally, it is an explosion which has to be carefully prepared for beforehand."

The question of starting large motors is one which has been solved in various ways, none of them perfect, but some of them fairly practical, and other methods of promise remain untried.

"The remainder of the difficulties still stand untouched. There is no margin of power. To explain, when a steam engine is overloaded it slows down and pulls hard. It not only has a respectable margin above the load of maximum efficiency before it begins to slow down, but it has a further wide margin of useful activity beyond that point before it comes to a full stop, and during which its speed is a ready indicator of how far it is from stopping. With the gas engine, however, the load of maximum efficiency is that of maximum capacity, but when a gas engine is so overloaded that it once begins to slow down there is no 'grunt and pull hard' to it. It stops; the entire load must be thrown off and a fresh start made."

The crudity of the method of regulation by means of missed impulses, and the great reduction of efficiency when the method of modified gas mixture is used, both show the necessity of devising some improved way of governing, while the problem of reversibility seems to have been accepted by designers as insoluble.

These objections must be carefully grasped and appreciated before the gas engine situation can be understood.

When it is considered that the power plants in operation using power gas in

motors form a very small portion of the existing gas engine installations in use, we are forced, as Professor Reeve points out, to the following conclusions: "That the gas engine has spread in use not because it is efficient, not because it is mechanically attractive, but, because its source of power-gas-is a fluid cheaply and conveniently transportable from a central source to a myriad of distant and isolated points of consumption; and that further, the first two arguments—expense and mechanical crudity—have been powerful obstacles in confining the expansive power of the latter argument—transportability—within exceedingly narrow limits."

The superiority of gas over steam for storage, transmission and subdivision, and its marked inferiority as to the motor itself—coupled with its very low cost when used on a large scale lead to the following important conclusions, which may be stated as follows:

"First, the ultimate destiny of the gas engine is inestimably wider than that of the steam engine even, and not to be compared with its present limits; and second, the gas engine which is to fulfil this mission must as a machine, not be content with an inferior approach to the lowest steam engine standards, but must take a high stand as its peer, or even its superior, in mechanical adaptability, delicacy and docility."

The line along which these improvements may be expected is in part indicated by a study of the narrow path traversed by past advance, and the high efficiency of the new Diesel motor is pointed out as due entirely to the extension of the operations to an unprecedented range of pressures. The prediction is made that his fuel rate per horse power hour is no better, and even not so good, as that which may confidently be expected from either the Cayley-Buckett, the Siemens, the Brayton, the Gardie, or any other such general type of engines, when once the designer may appear who is willing to undertake the commercial handling of machines adapted for such working pressures as 45 atmospheres, or 647 pounds per square inch.

The Strength of Sewer Pipe.

SOME experiments recently made by Mr. Frank A. Barbour, of the Boston Society of Civil Engineers, and published in the *Journal of the Association of Engineering Societies*, enable us to acquire some idea of the strength of sewer pipe and the pressures to which it is subjected in the ordinary course of usage.

The experiments were made so as to conform as closely as possible to actual practice, the pipe being laid in a trench in the usual manner, after which pressure was applied by a hydraulic machine to a platform—resting on a filling over the pipe. In the tests of earth pressure the same machine was placed in the bottom of a deep trench, and the earth filled upon a platform resting on the plunger, which communicated the pressure to a gauge.

The tests were made upon sizes ranging from 6 to 24 inches in diameter, and with both the standard and double-strength pipe,—of soft, medium and hard burned grades, as indicated by the manufacturers.

Mr. Barbour has sought to express the relation of the dimensions of pipe to its breaking strength by a formula which follows with reasonable closeness the curves deduced from his tests; but for all practical purposes it suffices to know that the breaking load per lineal foot averaged about 2,800 pounds for the standard pipe and 4,200 of that of double strength.

The trench experiments were made with filling of various materials, loam, sand, gravel, and clay being used, and the pressure transmitted to the bottom of the trench varied from 30 to 60 per cent. of the weight, according to the filling.

In general, the actual pressure at different depths was ascertained, and expressed as a percentage of the weight of earth superimposed. This value, in the case of loam and gravel, was found to be equal to the difference between unity and the coefficient of friction of these materials, and, if this relation extends to other materials, a means is afforded of estimating the actual earth pressures in trenches of all materials of which the coefficients of friction, or angles of repose, are known.

THE BRITISH PRESS

The British Coal Supply.

IN his annual address before the British Statistical Society, printed in the *Colliery Guardian*, the Right Hon. Leonard H. Courtney gave an interesting comparison between the rate of production of the British coal-supply predicted by Jevons more than thirty years ago, and the actual figures for the corresponding years; and, in connection with this, he discussed the general subject of coal production in Great Britain and other countries.

As long ago as 1861 Jevons, in his book entitled "The Coal Question," indicated that the rate of production of coal in Great Britain was a subject for serious consideration, and from the results of previous years concluded that, if the output of coal continued to increase at the rate then existing, the actual consumption would within a comparatively brief time overreach the means of supply; he therefore declared that the rate of increase which had been noted could not be upheld.

"As regards the fact of an abatement of the rate of production, the figures of experience abundantly justify the anticipations of Jevons. The rate of increase at the time he wrote was 3 1-2 per cent. per annum, and there was statistical proof that this rate had been maintained for some years before that time; there was further evidence leading to the presumption that something like the same rate had been the law of increase since the beginning of the century."

By taking the rate of 3 1-2 per cent. increase and comparing the computed output with the actual quantities it is found that, as a matter of fact, the rate of 3 1-2 per cent. has not been maintained. Making allowance for some disturbing elements, such as labor troubles previous to 1871, the rate of increase has continuously declined, until in the year 1896 the amount raised was almost exactly 30 per cent. below what it would have been had progress been unchecked.

Jevons also predicted an increase in price, which has only partially been fulfilled, for the very good reason that prices have to a certain extent been governed by foreign competition.

A large portion of this competition has come from the United States. "The figures show that, whilst in 1861 the total coal produce of the United States was less than one-fifth of the amount raised in the United Kingdom, the total quantities raised in the two countries had in 1895 approached nearly to an equality, and this result is of course due to the fact that year by year the rate of increase in the States was greater than the rate in the United Kingdom, and that on the other side of the Atlantic this annual rate, though subject to some variations, was, on the whole, maintained at the same level, whilst in the United Kingdom it has been almost continuously decreasing."

The suggestion has often been made that, long before the diminishing coal-supply becomes a matter of really serious moment, coal will itself have been superseded by other natural sources of energy; and this phase of the question was not overlooked by Jevons, although since his time the utilisation of distant hydraulic power and its transmission by electricity has become an accomplished fact in many localities in which he could hardly have thought it possible. There is no doubt that the harnessing of tide, wave, and wind power, to say nothing of the internal heat of the earth and the radiant energy of the sun, will ultimately do away with all necessity for the mining of coal; but this is a result which concerns the prosperity of Great Britain almost as deeply as the loss of her supremacy in the control of the energy obtainable from coal.

Speaking of such suggestions, Jevons said: "Such a discovery would simply destroy our peculiar industrial supremacy. Electricity has already been zealously cultivated on the continent with this in view;

England, it is said, is to lose her supremacy as a manufacturing country, inasmuch as her vast store of coals will no longer avail her as an economical source of motive power. And, while foreigners clearly see that the peculiar material energy of England depends on coal, we must not dwell in such a fools' paradise as to imagine we can do without coal what we do with it."

It is not the function of the statistician to point out the remedy or to serve as an alarmist, but, as a guide to future conduct, the lessons of carefully-prepared statistics are always of value. Mr. Courtney has shown that the predictions of Jevons have in great measure been fulfilled in the course of time, and, in concluding, he says: "The true way of meeting the difficulties of the future must be through spreading among the people an understanding of its probable course. In an intelligent appreciation of our situation lies the best promise of a perception of personal national duty."

The Water Ballasting of Steamers.

In estimating the amount and disposition of the water ballast for a steamship, the variations in the weight of coal to be carried must be taken into account. The changes which have been wrought by the introduction of improvements in the steam machinery have modified these variations very materially, and the change in the relation of total weight to displacement, caused by the substitution of steel for iron, has also to be considered. These and similar points are discussed in a valuable paper presented before the North-East Coast Institution of Engineers and Shipbuilders by Mr. Archibald McGlashan, of which we give an abstract.

The general tendency of the developments in modern shipbuilding have been: 1, to reduce the cost of ships per ton of deadweight capacity; 2, to reduce the draught of water on which ships may carry a given deadweight; 3, to reduce the consumption of fuel required to carry a given deadweight at a given speed. These improvements are all very desirable from the shipowner's standpoint, but they also bring about an important reduction in the light draught of a vessel under steam, which requires a correspondingly increased ballast, or other weight, to be put on board, so as to give sufficient immersion to enable passages to be made in ballast satisfactorily.

The main purpose of ballast in steamers is to increase their draught of water, so as to make them manageable in rough seas, and to immerse the propeller sufficiently to enable it to do its work in a reasonably efficient manner. In the case of deep and narrow steamers the most suitable place in which to carry ballast is the bottom. But steamers, as now built, have plenty of beam to insure stability, and it is not advantageous in them to carry in the bottom all the additional ballast which they require. Doing so would increase the metacentric height, which in such vessels is already considerable, and make them less sea-kindly in ballast.

It is found in practice that, under present conditions, it is advantageous not only to carry more ballast than formerly in ordinary cargo steamers, but also to carry it at a considerable height above the bottom. In addition to the usual double-bottom tanks, after-peak tanks are used, and are very efficient for trimming a vessel by the stern. Deep tanks are sometimes found in the holds, but are not in favor, as they present many inconveniences in practice.

Side tanks possess many advantages. They consist practically of the double-bottom construction carried up the sides of the ship, thus enabling the increased ballast capacity to be provided as necessary, and to be carried at such a height as to make the vessel easy in a sea way. Such tanks may also prove a source of safety,—as double bottoms have already been,—for injuries to the outer shell would probably fail to penetrate the inner tank plating, which would thus prevent water from reaching the cargo, and in some cases, might prevent the ship from sinking. Side tanks also interfere less than any other form with the stowage of the cargo, and render the hold space more valuable than when it is cut up by internal divisions.

As examples of various degrees of ballasting, a table of a number of vessels is

given; one of the most satisfactory steamers in the list had a displacement in the ballast condition of 0.521 of the load displacement, and a draught of water, in the same condition, of 0.589 of the load draught. These proportions are not given as an unfailing guide in determining ballast conditions for steamers, as other elements have a modifying effect; but under general conditions this vessel proved an admirable ship in ballast, and very satisfactory in service.

The importance of taking the modified conditions of ship construction and coal-consumption into account will be appreciated by all who have to deal with the question of ballasting vessels, and Mr. McGlashan's paper is a timely contribution to the subject.

The Development of Electro-chemistry.

THE inaugural address of Mr. J. W. Swan as president of the Institution of Electrical Engineers contains some interesting reminiscences of the past, particularly in connection with the development of the incandescent electric lamp, toward which his own inventions have so materially contributed. The bulk of the address, however, is devoted to the outlook in connection with electrical progress, and in that respect he is clearly of opinion that "those who are aspiring to make their mark as electrical engineers would choose wisely in making a very special study of that portion of the field within which lies the application of electrity to chemical manufactures."

Of this wide field only a small corner has been cultivated, but that is already yielding rich harvests. The electrolytic refining of copper, the extraction of aluminium, the recovery of gold, and the electrolytic production of chlorine and of soda,—all these are assured commercial successes, while a number of minor industries are partially dependent upon the chemical action of the electric current.

In reviewing the historical side of the subject, Mr. Swan called attention to the fact that chemical action was the earliest form in which the electric current, properly so-called, was manifested, and, from the time of Volta down through the fundamental work of Davy and of Faraday, the chemical production and utilisation of the current formed the principal subject of investigation.

From Faraday's time down to the present, the generation of current from mechanical energy has changed the trend of thought and work, and, while electroplating and minor electro-chemical work have been actively conducted, the main progress has been on other lines.

The production of a continuous-current generator by Gramme was the starting point of modern applied electricity. "The two succeeding decades saw the evolution of the modern dynamo; and at the end of this period the critical point was reached, when there was demonstrated, with sufficient clearness to captivate the commercial mind, the fact that, for lighting, for transmission of power, and for effecting several important chemical operations, electricity, as produced through the dynamo by the steam engine or by water power, was a thing of utility, and could be turned in all these ways to commercial advantage.

"These great uses of electricity have been for several years established on the secure basis of commercial success. This result has been reached through the co-operation of many minds, and especially by the union of the skill of the mechanical engineer with the specialised knowledge of the electrician and the chemist.

"Out of this combination and concurrence of forces electrical engineering has grown, and by making new demands has reacted beneficially on purely mechanical engineering. The requirements of electric lighting have largely contributed to those great improvements and economies in electric power-producing machinery, and in the steam engine itself, which have materially assisted in bringing about the degree of success which has now been reached in electro-chemical industries."

Copper-refining by electricity is the practical descendant of electro-plating, and follows from the early-ascertained fact that, no matter how impure the anode may be, only pure metallic copper is de-

posited upon the cathode plate. The development of this branch of electro-chemistry has been so great that now one-third of all the refined copper produced in the world is made by the electrolytic method. Not only is the process commercially economical, but whatever gold and silver may be in the unrefined copper are saved, while the resulting product is almost chemically pure, and hence of a much higher degree of electrical conductivity.

The reduction of metallic copper from the matte, while not yet fully developed, is an important subject for investigation, and already the Canadian Copper Company is successfully reducing copper-nickel mattes electrically, although as much as 14 per cent. of sulphur is present.

In the important field of gold extraction the Siemens & Halske process enables the cyanide process to be extended to solutions otherwise too weak to pay for working. The electric current will cause the gold to be deposited upon lead plates from an extremely dilute cyanide solution, and now more than 1,000,000 tons of tailings formerly discarded as worthless are profitably treated by this process every year.

The extraction of aluminium by electricity is one of the results of electro-chemistry which suggests what may be expected when the art is further developed, and applied to other substances now as difficult of extraction as aluminium once was; the Castner sodium process is another development in a similar direction.

The most important of all the forms of applied electro-chemistry, however, is the electrolytic production of the alkalies. Hardly has the Solvay process superseded the older method of Le Blanc when the application of the electric current to the production of alkali and chlorine by the decomposition of alkaline chlorides appears, promising to develop into an industry which shall overshadow both its predecessors.

These and many others are but examples of what may be done in the application of electro-chemistry in the industrial arts, and, as Mr. Swan says, it is but the fringe of the matter which has been touched. Already a large amount of valuable work has been done, but there is a limitless prospect of expansion.

The main question for the mechanical engineer in all this lies in the economical generation and application of power. At the present time water power is generally looked upon as the most economical source, but it is possible that, when all costs are included, steam power may be a close rival. The conditions under which steam power is used in electro-chemical manufacture are extremely favorable to economy, where coal is cheap, the unit of power large, and the use of power continuous and uniform.

"In the time that has passed, Britain has enjoyed in chemical manufactures a great advantage in the possession of an abundance of coal. We are about, in some measure, to lose the benefit of this advantage through the innovations of electro-chemistry. Whether we profit or lose by the change largely depends on our readiness or unreadiness to adapt ourselves to the new order of things."

Hydraulic Motors.

In adapting water under pressure to the generation of power, one of the practical difficulties has been the excessive waste when running under light loads. No matter what the load may be, the cylinders must run full of water, and, the governing being effected merely by throttling the supply, there is no opportunity for economy.

This feature of piston hydraulic motors is discussed by the well-known engineer, Mr. Arthur Rigg, in a recent number of *The Engineer*, in connection with an account of an improved device of his own invention, intended to remedy the difficulty.

Since there is only a liquid under a positive pressure to be considered, there is no expansive force to be dealt with, hence the most obvious way of altering the power of a motor is that of varying the stroke,—an idea applied as long ago as 1858 by Messrs. Knowlden and Edwards, who made a three-cylinder engine in which the radius of the crank could be changed

by the action of two hydraulic rams. Pressure was conveyed through the centre of the shaft, and it was intended that the stroke should be changed while the motor was running; but the device does not seem to have been a success, probably from constructive reasons. Several other attempts have been made, the best known being that of Mr. Hastie, of Greenock, in which the radius of the crank was varied by a cam acting against a spring resistance in such a manner as to form a dynamometric governor, the stroke being lengthened as the resistance increased, thus giving greater leverage to the pressure upon the pistons.

The difficulty of adjusting the stroke while the engine is in motion, Mr. Rigg gets over in a very simple and ingenious manner. He uses an inversion of the ordinary type of motor, and causes the crank to stand still while the cylinders revolve around it, thus making it possible to so connect the crank to a governing mechanism as to enable the pressure water to be used in proportion to the work done, while a close approximation to a uniform number of revolutions is maintained.

The mechanical details by which this system is executed may be varied, but the principle remains the same. In the motor shown, which is used for driving a grain elevator, the crank pin is shifted to or from the centre by means of auxiliary hydraulic cylinders controlled by a centrifugal governor, and the power developed varies between 20 and 4 h. p.—a saving, in comparison with engines of fixed stroke, that sometimes amounts to 80 per cent, for light loads.

The Utilisation of Blast-Furnace Gases.

REFERENCE has already been made in these columns to the successful use of blast-furnace gases in gas engines in Belgium, and this problem has also been successfully attacked in England.

In an article in the *Electrical Review* (London), dealing principally with the subject of the generation of electricity by gas power, this question of blast-furnace gases is also mentioned, especially with reference to the tests of Mr. W. H. Booth on the Thwaite blast-furnace power system.

"Basing his figures on an assumed production of 200,000 feet of gas per ton of fuel, the consumption of gas per electrical horse power was found to be 133 feet per hour. The 200,000 cubic feet were obtained from the gas analysis. With slightly different furnace *régime* and the works manager's figure of only 180,000 feet per ton, Mr. Booth gives the consumption per e. h. p. as only 105½ cubic feet. These figures entirely neglected the amount of heat that disappeared in the pig bed and in the slag, etc., showing how very efficient as a gas-producer the blast furnace proves to be, and indicating not only the high economy to be secured from the method of utilising the waste heat of the blast furnace, but pointing to a time when the manufacture of producer gas will be carried on upon a large scale, the working of producers being best when of large size. Indeed, the blast furnace, though designed to produce pig iron, is an ideal gas-producer, and, while we envy America her Niagara, we have in England, within easy reach of every large town, large power-producers from which at present very little is being done. Look at the matter from whatever way we will, it appears that gas power in the near future will more and more encroach upon the field hitherto filled by the steam engine. We do not think that the use of illuminating gas, to give the mixture its courtesy title, will ever prove commercially economical for stations of any serious power. To be a success, gas of the producer type must obviously be employed, and it is most important that the producer plant be constructed in a thoroughly mechanical manner. We have seen promising power stations ruined from want of attention to this point. There is no occasion for dirt, dust, and smoky fumes in a gas-producer house."

That the gas engine is destined to crowd the steam engine very hard as a generator of power from heat we have long believed and frequently emphasised, and the present revival of interest in both engines and

producers indicates that the general introduction of internal combustion motors in large units is the next great change which we shall see in the industrial application of power.

By uniting the smelting of iron with the production of power gas two of the greatest industrial operations in the realm of applied science will be combined, and in England especially, where the question of competition with the cheap hydraulic power of Switzerland, Germany, and even Norway is impending, this utilisation of the power now wasted in the discharge gases of blast furnaces may prove of the utmost importance.

The Protection of Iron from Rust.

THE use of paint as a protection from rust is so general that to attack its efficacy seems almost a heresy, and yet it is well known that the protection it affords is only partial, and that, in spite of many and frequent coats of paint, iron work will rust. A leading article in *The Engineer*, in discussing this subject, shows that there are many good reasons why paint should not be an efficient protecting material The pigment contained in a paint possesses no protective value in itself, dependence being really placed upon the liquid matter alone; hence, in using heavy coloring matter, assuming that the proportion of oil per square foot remains constant, the engineer is simply paying more money for a substance not only of no service, but positively deleterious to the rest of the material.

Linseed oil, however cannot be used alone, since it expands on drying, and the resulting film is apt to be rugose; moreover, if the adhesion of the oil to the metallic service is not perfect, it may cause the production of blisters. The lack of stability possessed by the solid body resulting from the oxidation of the oil also causes it to crack and fall to pieces; hence as a protection against rust it is not successful.

Varnishes have been suggested, but many of them are apt to crack and peel, or else are so porous as to permit moisture to penetrate. A few varnishes are free from these defects, but their cost renders their use for this purpose impracticable.

Better results in many ways are obtained by the use of such materials as tar, pitch, or asphaltum, and, although they may not altogether respond to the demands of the ideal specification, they will be found to possess many serviceable qualities. Coal tar has been charged with possessing a corrosive action upon iron, although this action is said to be prevented by heating with lime; but pitch, softened with creosote and dissolved in one of the cheaper light oils recovered during distillation, or in a corresponding petroleum derivative forms an excellent protective varnish.

Asphaltum dissolved in a spirit solvent is also suggested as a safe and suitable paint for the protection of iron work, and this may also be used in connection with linseed oil for a second coat. This, indeed, seems to form the ideal combination. The iron should first be cleaned from all scale or rust, and every trace of moisture removed, after which a thick priming coat of pure boiled linseed oil is applied, and carefully worked into all cracks and crevices. When this has become perfectly dry and hard a second coat of black varnish, composed chiefly of pitch or asphaltum should be applied, the combination forming the best protection against rust at present available.

Probably in this connection the use of the sand blast for obtaining a thoroughly clean surface would greatly assist the protecting medium by enabling it to make a perfect contact with the surface of the metal.

The Electrical Driving of Machinery.

IN his presidential address before the Northern Society of Electrical Engineers at Manchester, Mr. John Raworth utters a number of timely and vigorous remarks about the advances in the application of electricity which ought to be made without delay, and one of the most important of these he declares to be the driving of machinery for manufacturing purposes by electrical distribution of power, including the total abolition of line shafts, countershafts, wheels, ropes, pulleys and belts.

"The day for tinkering with this problem is now over; every man knows that it can be carried through with absolute certainty, with satisfaction to the manufacturer, and with enormous saving both to himself and the community. But the manufacturer does not yet know that the shaft of his machine can be fitted with a three-phase motor without commutator or brushes, and less complicated than his present double pulley and strap fork. When you have succeeded in impressing him with this fact, the remaindar of your task will be an easy matter, but it must be undertaken methodically. The first step is to appoint a commission to settle uniform periodicity and voltage; the second is to equip an electrical manufactory capable of turning out 500 cheap motors per week; the third is for machine makers to attach the motor in place of their present pulleys, so that when a manufacturer buys a machine, he buys it all ready for attachment to his power circuit.

Having reached this point, it is obvious that the manufacturer will no longer desire to buy coal; he will be quite satisfied with watts, which may be produced at the pit's mouth and sold retail for less than they can now be supplied mechanically to the machine axis.

The whole question of external supply of power turns on this question of economics. Your manufacturer will not care two straws for your electrical development or for the annihilation of the smoke cloud which he interposes between the sun, the source of all our joys, and the dismal streets of Manchester; but his eyes will gleam with rapture if you can prove that you can save him a thousand a year.

Happily your task is an easy one so far as argument is concerned; and if illustration be required I am not sure that we members of this society could spend our savings to better advantage than by taking a representative deputation of Lancashire and Yorkshire manufacturers through Switzerland and Germany to show them how the old order is giving place to the new; how the millwright is disappearing in favour of the electrician; how 25,000 mechanics are struggling to keep pace with the demand for electrical machinery, of which about three-fourths is required for electrical purposes.

In America the same process is going on, so it follows as a matter of course that we must either quicken our pace or drop out of the running altogether.

Happily the coal pits around Manchester are so close to the city that there will be no new difficulties in transmission, and a very moderate voltage will suffice. It is obviously outside our province to discuss the various possible methods of raising the capital. My own impression is, that when the profitable nature of the investment comes to be understood, there will be no difficulty in raising a million to put down a pioneer plant of 50,000 horse power with an earning capacity of close on £200,000 per annum."

All this is very true, except that Switzerland and Germany and many portions of America have water power available, while this in England is mainly lacking, and this Mr. Raworth perceives, for he proceeds to show how with the introduction of electrical driving more economical and efficient steam engines must be developed.

"Although we make good steam engines, in spite of of American comments to the contrary, we have not made economy our first consideration; we have, moreover, been confirmed in this practice by the belief that economy of coal could only be obtained by increased capital expenditure and troublesome complications. But that view is totally and fundamentally erroneous."

For large units and for fairly uniform loading a high economy can be obtained with engines by no means either complicated or of high first cost. In this connection Mr. Raworth referred to multiple expansion engines and especially to the Schmidt superheated steam motor, more fully described elsewhere in this issue, and urged upon English engineers to exert themselves to fill the coming demand both for electrical and power plant and not permit it to be captured by foreign competitors.

Engineering in 1897.

AN excellent review of the progress which has been made during 1897, in the various branches of "the art of directing the great sources of power in nature for the use and convenience of man" is found in a late issue of *The Engineer*, and some of the salient features there brought out, are well worth considering, especially for the bearing which they have on the engineering work of the present year. Although this review naturally deals principally with British engineering, it includes also important work in other parts of the world and thus gives from a British standpoint a picture of the doings of the engineer in the past year at which we may well take a thoughtful look.

In civil engineering, naturally the greatest works have been those involving the development of new countries, or rather the re-development of very old countries. England's position in this respect is summed up in a few words, which are full of meaning: "All we have to do is to keep ourselves thoroughly well abreast with the times, and with the men of other European nations, bearing in mind that a certain and a very fair portion of the work must be reserved for us by virtue of its position on British territory."

Russia has been, and still is pushing forward the work on the Siberian Railway, and incidentally is reported to be exerting pressure upon China to exclude English engineers on internal works. In India nearly four thousand miles of railway are under construction, while in Africa the completion of the Buluwayo extension is only a fraction of the exploitation of the southern portion of the dark continent by the engineer.

The replacement of the Victoria tubular bridge at Montreal by a modern cantilever is an excellent example of the progress in long span bridge construction which has been made in the past fifty years; while in India and Australia a number of important bridges have been built, and others are contemplated.

In mechanical engineering the two branches of locomotive construction and marine engine building have occupied the greatest share of attention although but little that is really new can be recorded. Compound locomotives on land, and water-tube boilers at sea, have evidently both come to stay; while the steam turbine has maintained itself as an object of interest with a future before it which the coming year may convert into something more than a promise.

The work of the military engineer has been along the old lines of "gun against armour," with the latest advantage on the side of the projectiles, but with the armour a close second. Quick-firing guns have been, and are still being improved, and it is a question whether in naval warfare at least, this portion of the armament may not develope into a position of controlling importance.

Sanitary engineering has made slow but constant progress, and the two great branches of pure water supply, and purified sewage discharge have at least gained in status, if not in execution. The whole broad subject of municipal engineering, including water supply, paving, lighting and drainage has during the past year made distinct progress, but its future is yet before it and not "behind it," as has been humourously remarked of certain other subjects.

Electro-chemistry is the branch of electrical science which has made the greatest advances of late, probably because it was the branch in which the least previous work had been done, and even now the best work and closest study is being given in Germany and in France rather than in England.

Altogether the engineer has done good work in 1897. Travel by land and by sea has been rendered swifter, safer, and less wearisome. More power has been obtained from burned coal than ever before, and other ways of obtaining power than by burning fuel have been developed. Harbours have been improved, waterways extended, rivers spanned, and railways built. It will not be long before a similar record will have to be made for 1898, and the present outlook indicates that progress will be along the same lines and at an accelerated rate.

THE CONTINENTAL PRESS

Superheated Steam.

In nearly all of the recent researches into the question of the internal wastes of the steam engine the question of cylinder condensation has shown itself a most elusive problem. Jacketing has proved a palliative only in certain cases, compression has been shown to cause nearly as much loss in one direction as saving in another, while reheating, in the case of multiple-expansion engines, has not given as yet the economy hoped for. Superheating was one of the earliest methods proposed to reduce cylinder condensation, and it has been mainly due to constructive and operative difficulties that it has not received as wide an application as its merits warrant. While it has never been as generally abandoned on the continent as in the United States or England, it is only recently that systematic efforts have been made to improve superheaters and to design special engines for the use of superheated steam as a medium for the transformation of heat into mechanical energy. In Alsace and in England the question of superheating has been taken up anew; in the United States Professor Thurston, and in Germany Professor Schröter, have directed attention to the subject; and in France, Belgium, and Italy it is again being discussed.

A valuable series of articles upon the application of superheated steam in engine practice, written by Professor Sinigaglia, of the engineering school at Naples, has appeared in recent issues of the *Revue de Mécanique*, treating the subject from both a historical and practical point of view; while, in the *Zeitschr. des Vereines deutscher Ingenieure*, Professor Seeman, of Cannstadt, discusses engines for use with superheated steam, and especially the Schmidt engine, which, during the past year, has given some very excellent results.

Professor Sinigaglia refers to the remark of M. Bertrand that what we call saturated steam really does not exist in practice, since a very slight change of pressure or temperature is sufficient to make the difference between a superheated steam and a mixture of steam and water. In a working engine, therefore, the fluid in the cylinder is always in a state of instability and subject to very complex conditions, and it should be our effort to render these conditions as favorable as possible for the utilization of the energy of the heat.

Much attention has been given to steam economy in Alsace; indeed, Professor Unwin not long ago said that in the use of steam the Alsatian engineers had accomplished better results than any others. M. Walther-Meunier, the chief engineer of the Alsatian Association of Steam Users, has made a great number of tests upon engines using both saturated and superheated steam, and in his extracts from these reports Prof. Sinigaglia gives valuable comparisons between various methods of working, and shows just what degree of economy may be expected.

Among these tests may be noted those of MM. Ludwig and Weber upon the steam plant of MM. Kulmann & Co., at Wittenheim. In this case a triple-expansion engine of the Frikart type was supplied with steam by a battery of elephant boilers, and an independently-fired superheater of the Uhler style was applied. The trials were made with conditions as nearly uniform as possible, excepting that the superheater was used in the second series, so that the difference, if any, should be clearly accounted for. In the article referred to, the results are fully tabulated, and, in brief, the steam-consumption in a 700-h. p. triple-expansion engine operating at 160 pounds' pressure with saturated steam was 13.2 pounds per h. p. h., while with 75° F. superheating this was reduced to 11.7 pounds,—a saving of 2.5 pounds, or 19 per cent. Another test upon the engines of the spinning mills at Mulhouse,

on an 800-h. p. triple-expansion Corliss engine, operating with steam of 164 pounds pressure, showed a consumption of 14.2 pounds of steam per h. p. h., without superheating, while with 75° F. superheating the consumption fell to 11.3 pounds.

In these cases, however, the superheated steam was used in engines originally intended for saturated steam, or at least for the moderately-superheated steam obtained in well-designed boilers without special superheating apparatus.

In the article of Professor Seeman to which reference has been made the question of using a much higher degree of superheating, in engines especially adapted for such conditions, was discussed, and tests of the Schmidt superheated steam engine were given in detail.

The Schmidt engine possesses several peculiar features, which may be briefly noticed. It is a single-acting compound engine with both cylinders in the same axis and with a differential plunger piston, the high-pressure cylinder being formed in the head of the low-pressure cylinder. The crank end of the large cylinder constitutes a receiver of varying capacity, while the annular space around the plunger in the head end of the large cylinder forms the low-pressure cylinder.

The steam first enters the high-pressure cylinder, from which it passes to the receiver space in front of the large piston; on the next out-stroke it flows from the receiver to the annular low-pressure space, whence it exhausts to the condenser, while the compression takes place in the receiver. The distribution is effected by poppet valves, operated by eccentrics upon a side shaft geared to the main crank shaft.

The first engine of this sort, of 60 h. p., was tested early in 1895 by Professor Schröter, with steam at 160 pounds' pressure and 280° F. of superheat, and gave the remarkable steam economy of only 10.46 pounds (4.55 kilograms) of steam per h. p. h. while a similar engine of 120 h. p., tested by Prof. Seeman in November, 1896, with a steam pressure of 164 pounds and a superheat of 290° F. gave an i. h. p. with only 9.8 pounds 4.44 kilograms) of steam per hour!

Hydraulic Mortar.

CEMENT and mortar tests have been so extensively made and discussed that the subject may seem almost exhausted, but the value of such tests depends so much upon the manner in which they are conducted and investigated that a study as scientific as that made by M. Feret, the head of the laboratory of the *Ponts et Chaussées* at Boulogne, and published in the *Bulletin de la Société d'Encouragement*, demands recognition.

M. Feret first describes and tabulates the extensive series of tests for resistance to tension, compression, piercing, and shearing which were made in the laboratory under his charge, the same Portland cement being used in all cases, in connection with various kinds of natural and artificial sands, the intention being to investigate rather the physical properties of various mixtures than the comparative merits of different cements. The results are given in tabular form, and also plotted in curves, showing graphically the general behaviour of the materials, after which the effect of variations in a series of test samples is discussed.

Attention is called to the fact that widely-different results may be obtained from the same material, according to the manner in which the tests are made, and emphasis is strongly laid upon the point that tests are not comparable unless they have been made in the same manner.

In tests for flexure, for instance, the size of the specimen is of great importance, since the distance of the outer and more resistant portion from the neutral axis has a great influence upon the result, and in general the greatest resistance of any specimen is found in that portion nearest the exterior. An unequal distribution of stresses must, therefore, appear in tension tests as well as in those for flexure, and this inequality is still greater when the mixture is not perfectly homogeneous.

According to the theory of resistance of materials, tests by flexure and by tension should lead to the same ultimate strength, but deductions based upon materials of supposedly perfect elasticity do

not hold good for mortars, especially as the point of rupture is approached. M. Durand-Claye has shown that the resistance deduced from flexure tests is almost double that obtained from direct tension, and the tests of M. Feret bear out the fact that there is a definite ratio between the two resistances,—namely, the resistance by flexure is to that by tension as 1.89 to 1, or, in round numbers, as 2 to 1.

Similar relations were deduced between the resistance to compression and to shearing and punching, a constant and proportional ratio being found. There does not appear, however, to be any such proportionality existing between the results obtained by tension and by compression tests, and two different mortars having the same resistance under compression may show very different results in tension. As a result of much experience deduced from many tests, M. Feret states that he believes the test by compression gives the real measure of the coherence of a mortar more nearly than does a tension test. In all cases the compression tests gave more uniform and consistent results, both for large and small specimens and for various conditions of homogeneity.

The most important part of M. Feret's paper, however, is that relating to the physical constitution of a hydraulic mortar, especially with regard to the size of ultimate particles of the materials employed, and to the thoroughness of the admixture.

For a very fine sand the resistance to crushing is much greater than for a coarse sand, the proportion of sand to cement being the same in both cases. A tabulated series of tests, using a constant quantity of cement and sand, but with different proportions of fine and coarse sand, showed that the resistance to compression was two and one-half times greater with fine sand than with coarse, and corresponding variations appeared with the other mixtures.

An approximate measure of the nature of a mortar in this respect may be obtained by determining the density, or, as M. Feret calls it, the "compactness," of the mixture, since this bears a relation to the proportion of voids between the particles, which doubtless plays an important part in the strength of the mortar. In plotting the results of the tests made with sands of various degrees of fineness, M. Feret uses the ingenious form of triangular pyramid adopted by Professor Thurston in his investigation of the strength of various bronzes, and in this manner the results are shown with a clearness not otherwise possible. Similar diagrams are given for mixtures of sand, cement, and pulverized slag, and the paper closes with data as to the effect of the addition of a proportion of puzzolana to cement and sand, especially for hydraulic mortars which are to be exposed to the action of sea-water.

Current Motors.

In utilizing the energy of water-courses such streams are generally chosen as have sufficient fall within moderate length to permit the development of a considerable head, or preferably such natural waterfalls are taken as need but little constructive work for adaptation to power generation.

There is, however, in all flowing streams a large amount of energy existing in the force of the current, and from the earliest times current mills in crude forms have been constructed to enable some portion of this power to be utilized.

In view of the present desire to obtain cheap motive power, this subject of the utilization of flowing streams is being revived, and in a recent issue of *La Revue Technique* an account is given of the von der Heydt system of current motors, which contains much of interest.

The fundamental principle of the von der Heydt system is the employment of a floating or submerged dam, which contains in itself the motors and electric generators by which the energy of the current is transformed, and which may be swung aside bodily when it is necessary that the water-way should be unobstructed for purposes of navigation.

In the simple instance of a small stream, the dam consists of one pontoon as long as the width of the channel, divided into

a number of compartments, each compartment containing a turbine on a horizontal axis geared to a generator in a water-tight chamber above. The pontoon is held in position across the stream by suitable cables in such a manner that it may be swung alongside the bank at short notice, and, by the filling of certain compartments with water or with air, it may be submerged or floated at will.

The flow of the current, due to the natural slope, provides a large part of the power, and this is augmented by the rise due to the obstruction of the water by the dam. Even where the natural current is slow, the large volume of water in many streams represents much power, and M. von der Heydt estimates that on the Rhine between Bingen and Coblentz 1,000 h. p. may readily be taken off without appreciably affecting the general action of the river.

For wide streams the dam may be divided into several sections, and possibly one or more piers may be required in the middle of the channel, in order to facilitate the support and control of the pontoons. When the depth of water is great enough to make it necessary, a sort of flap is provided beneath the pontoon proper, in order to prevent too much of the current from passing beneath, and special arrangements of details may be necessary for special locations. The independent action of a number of turbines thus ranged across a stream permits each to adapt itself to the velocity of the current at its particular point without interfering with any of the others, the only connection being the feeding of the various generators into the same circuit. The use of accumulators provides for any irregularities in flow, and also maintains the current when for any reason the dam is swung aside.

Experiments made on a dam of this construction at Coblentz enable definite data about the system to be obtained. The river at that point is about 1,000 feet wide, and the presence of the dam raised the level of the water about one foot. A flow of more than 20,000 cubic feet per second resulted in the development of about 2,500 h. p. M. von der Heydt makes an allowance of 50 per cent. for losses, including the time the apparatus is out of use, and assumes that 1,200 h. p. may be taken as the output.

From such preliminary data as could be deduced from the cost of this experimental installation, making liberal allowance for interest on the original capital as well as for depreciation of the dam and its contained machinery and including all necessary operating expenses, the cost of an electrical horse-power with this device would be about 140 francs per year.

The idea of using floating pontoon dams for power purposes was suggested, doubtless, by the action of the various pontoon bridges across the Rhine, and for many locations this system may enable much power now wasted to be utilized.

The Dortmund Canal.

THE agitation in Germany for better and cheaper internal transport still continues, but it is found difficult to harmonize the conflicting interests of different localities. Especially in the mining region of Westphalia there exists a continual demand for relief, not only from the cost of rail transport, but also from the congestion which frequently occurs when low water in the Rhine delays river traffic and causes the railways to be crowded beyond their car-capacity.

This phase of the subject was discussed with much energy at a meeting held recently at Essen, of which an account is given in *Glückauf*, and the claims of this important industrial portion of Germany were urged in no uncertain manner.

The general extension of the canal system of Germany as proposed and discussed at the various conferences at Berlin, Vienna, and Hanover, including one or more systems of continuous waterways between the Danube and the North sea, has met with so much opposition from the agricultural portion of Central Germany, because of the feared influx of Hungarian grain, that its final acceptance is most uncertain. Such being the case, the mining industries of Westphalia and the Ruhr districts are urging the construc-

tion of only that portion of the work which will suffice to give a water outlet at all times from Dortmund to the Rhine.

As Councillor Behrens plainly said: "The situation is such that no plan for a midland canal can hope to go through. It would fall before the opposition of the farmers of the Elbe, before the opposition of the manufacturers of Silesia, and especially before the opposition of the lignite industry of Saxony."

A canal from Dortmund to the Rhine could excite no apprehension as to an influx of foreign grain, but it may meet a more powerful opposition from the railway monopoly which now controls the transportation in this densely-populated portion of Germany.

The proposition to construct a canal from Dortmund to the Ems, and thus to the North sea, did not meet with the same favor that the proposed Rhine canal met with, as the latter not only would be shorter, but would give access to the great public waterway, and make the entire district free from the exactions and limitations of the present monopoly.

The outcome of the present agitation cannot now be foreseen, but the pressure for better service is so strong that it is probable that, before a great while, the matter will take tangible shape. The miners and iron manufacturers know what they want, and they form altogether too powerful and influential a portion of the community to be easily suppressed.

Explosives in Gaseous Mines.

THERE have recently been several important investigations in different countries concerning the conditions of ignition of explosive gases in mines, the intention being to prevent as far as possible the danger in working mines in which the existence of firedamp is suspected, or even positively known.

A frequent cause of mine explosions lies in the ignition of the firedamp by the action of the mining explosives, such as nitro-glycerine, dynamite, and the like; and, in a paper in the *Oesterr. Zeitschrift für Berg- und Hüttenwesen*, Gen. von Lauer discusses very thoroughly the behavior of various blasting explosives in this especial respect.

A frequent cause of gas ignition lies in the discharge of unburned combustible from the bore hole, or rather of still burning material into the combustible atmosphere of the mine. This is a common defect of ordinary gunpowder, and it is well known that the ground in front of a battery which has been in action is often covered with unburned powder which has been thrown out by the force of the discharges. For mining purposes it is therefore most important that complete and rapid combustion should be insured, and that no unburned or burning material be thrown out.

Another important feature is that of the size of the charge. Explosions are much more apt to occur with heavy charges than with moderate charges. The size of charge used should bear an intelligent relation to the work to be done, and von Lauer discusses what he terms the "coefficient of charge," which is intended to enable the charge for any given case to be little more than necessary to rend the rock, without blowing out an excess of highly-heated gases. Of course any attempt to compute this coefficient must depend largely upon empirical conditions, but tables are given for various kinds of rock as well as for coal, using different well-known explosives, from which a general idea can be obtained.

The direction in which the bore hole is run also has an effect upon the completeness of absorption of the force of the explosion; when the hole is run downward in an inclined direction, there is more probability of an effective rending of the rock, and less likelihood of a discharge from the bore hole, than when the latter is run in at right angles to the surface of the rock.

An important question in connection with the use of explosives in mines is the temperature of explosion as compared with the temperature of detonation of the mine gas. The experiments of the French commission determined the limit of the exploding temperature of firedamp to be 2,200° C. This temperature is exceeded by some of the nitro-glycerine explosives, but

with the ammonia-nitrate explosives, and with explosives prepared especially with this end in view, the temperature of explosion may be kept low as 1,200° to 1,900° C.

A large number of actual cases of various kinds are tabulated and discussed, these serving chiefly as material for determining the best proportions of explosive to be used. In conclusion, the following general points are laid down:

"In mines containing explosive gases any blasting explosive which contains no non-combustible or non-gas-forming material may safely be used, when:

1. The charging of the holes is carefully proportioned to the work to be done, so that too violent explosions may not occur;

2. The charges are exploded by central ignition;

3. The primer by which the explosion is effected contains a sufficient quantity of fulminate to insure a complete ignition of the entire charge, preventing the throwing out of any deflagrating material;

4. The tamping with which the bore hole is closed extends from one to one and one-half times the length of the loaded portion, thus rendering a discharge of the explosive out of the hole impossible."

The Renewal of Incandescent Lamps.

MANY attempts have been made to restore the burned-out filaments of incandescent lamps and thus save a large portion of the material now lost, but thus far little success has been attained. In an article in the *Elektrotechnische Zeitschrift* a review of the various methods proposed is given, with some comments upon the causes of failure, which may be of value in further experiments.

One of the earliest methods was that proposed by Hess in 1891, and consisted in opening the sealed tip, filling the bulb with a liquid hydrocarbon, and repairing the filament with the deposited carbon. While this could be done, it was found that a filament thus repaired soon broke at another point, and that the real life of the lamp was prolonged for only a very short time.

Other attempts—notably those of Ponthonier, Möhrle, Chapman, and Carey—involve the attachment of a fresh filament to the original supports, but these have failed, either from cost or from imperfect connection, while the use of stoppers is hardly practicable as a means of securing a permanent air-tight joint.

The latest method proposed is that of Herr Becher, of Vienna, and requires the use of a special form of bulb with a longer neck than is now customary, this neck being also sufficiently wide to permit a looped filament to be passed through it. The terminal wires are of platinum only where they pass through the glass, and have nickel continuations with tubular clips at the ends, to which the ends of the carbon filament are attached.

When a loop needs renewal, the neck is cut, the burned-out filament removed, and a new one inserted into the clips. The new loop is then passed through into the bulb, and the neck fused together, after which the lamp is exhausted and is again ready for service.

It is claimed that this can be done at a cost of only six pfennigs, which is reasonable enough, but it is a question whether so low a cost can be realized, and, unless a much lower figure than the price of a new lamp can be assured, no method of repairing incandescent lamps can hope to be commercially successful.

Stone Cutting With Wire Saws.

AN account of the St. Triphon stone quarries near Bex, in the Rhone valley, is given in a recent issue of the *Schweizerische Bauzeitung*, which is of interest because of the successful use there of the system of sawing the stone by means of a continuously-running steel wire charged with wet sand.

The wire used for this purpose is of steel, and consists of a three-strand cable, about one-fourth of an inch in diameter, which is carried in the form of an endless rope over a system of pulleys. The pulley at one end of the system is the driver, and that at the other a tightener, while the intermediate pulleys are so arranged as to enable one part of the rope to be pressed against the portion of stone from which the block is to be cut.

The cable is driven at a speed of 1,000 to 1,200 feet per minute, and, as it enters the cut, it is charged with a siliceous sand in a small jet of water. The sand, carried in the twist of the cable, forms the actual cutting material, and performs its work rapidly and well.

The stone quarried at St. Triphon is a hard black limestone of the lias formation, with a crushing strength of about three hundred tons per square foot, and hence offers a very fair test of the capabilities of this substitute for the usual method of sawing stone with reciprocating saws. The rate of cutting varies with the quality of the sand used and with the length of cut, and ranges between three and six inches per hour.

The cables are furnished in reels of 3,000 to 5,000 feet in length, and a running cable contains about 500 feet, the splicing being done at the quarry. Such a cable can make cuts of 100 feet long, if necessary, and will dress about 1,000 square feet of surface, or more than 500 square feet of cut, before it becomes worn too smooth to hold sand.

The general working of this method at the quarry is very simple. In order to remove a ledge of stone, it is necessary to cut pits about a yard in diameter and as deep as the ledge, or, rather, as the desired cut. The frames carrying the guide-pulleys for the cutting portion of the cable are then braced in two of these pits between which the cut is to be run, and the cable is started. At first it runs upon the surface of the rock, but, as the guide pulleys are fed downward, the cut is carried down to the full depth of the pits. Several cuts can be made between the same pits, until finally the ledge is entirely cut into blocks which are held only by their bottom surfaces and can readily be split off by wedges. These large blocks are then removed by a powerful electric traveling crane, and further sawed into any desired sizes, after which the crane again loads them upon the cars for transport. The crane is rated at a capacity of 30 tons (metric), but a block containing 460 cubic feet and weighing 33 tons has been quarried and handled successfully.

Iron Theatre Construction.

FIREPROOF construction is nowhere of greater importance than in auditorium buildings, and often the knowledge that a theatre is not fireproof has much to do with the development of a panic at slight alarm, while the contrary assurance tends greatly to quiet a frightened audience. It was such considerations which led to the rebuilding of the Variety Theatre at Prague, and the account of the conversion of this dangerous wooden structure into a first-class fireproof theatre, as given in the *Wiener Bauindustrie-Zeitung*, is a valuable contribution to this branch of work.

The old building was a wooden hall, 90 feet wide and 105 feet long, with exposed wooden roof trusses of simple construction, and several years ago it was decided to be an unsafe structure in which to permit large crowds of people to assemble. New plans were therefore prepared by the architects, Professor Ohmann and Herr Rudolph Krieghammer, for the conversion of the old hall, not only into a fireproof structure, but also into a modern theatrical auditorium.

In the article referred to the arrangement of the iron construction is very clearly shown, especially the manner in which the oval iron ceiling is suspended from the main roof trusses, and also the cantilever construction of the galleries. There are seven main roof trusses of 93 feet 6 inches span, from which the framework of the ceiling hangs. The central portion of the ceiling, as already stated, forms an oval vault, and this is intersected on the lines of the two axes by cross vaultings, the whole forming a very complicated system of framework, extending to the walls in a series of arches and lunettes. This is to be covered with a layer of concrete three-eighths of an inch thick, and the columns and cantilever beams which support the boxes and galleries are protected in a similar manner. A circular opening is provided in the centre of the ceiling directly over the great chandelier, and a sheet-iron ventilating shaft communicates with the outer air for ventilation as well as safety.

The working drawings accompanying the article show very clearly the details of this excellent piece of auditorium construction, and among the various parts may be mentioned the suspension of the proscenium arch from the main roof truss overhead, and also the details of the gallery construction. These and other features are also well shown by photographs of the work in course of construction.

The whole forms an excellent example of engineering work as applied to a special form of building construction, and, as such, is worthy of study and record.

Business Methods in Russia.

IN discussing the subject of trade with Russia, especially in the branch of machinery and engineering supplies, M. P. Jannetaz brought before the *Société des Ingénieurs Civils de France*, a short time ago, the importance of complying with Russian business customs in order to obtain success.

As a matter of fact, Russia purchases almost all the machinery that she uses, the annual expenditure for tools and supplies of all sorts amounting to nearly 160,000,000 francs per year. As the portion of France in this large trade is only about 2,000,000 francs, M. Jannetaz thinks it worth while to examine the causes which permit other countries to obtain a disproportionate share, and his account of the business methods in Russian machinery trade are interesting.

M. Jannetaz refers especially to an important and interesting work by M. Verstracte, the French consul, which bears the title of "*La Russie Industrielle*," and includes mining and metallurgy, machinery, civil engineering, textile industries, manufactured products, and industrial art, as well as primary and technical instruction.

According to M. Verstracte, the Russian customer is a ready purchaser of articles which he can examine and handle, and is an interested visitor at fairs and exhibitions which give opportunity for actual inspection of machines and methods. Catalogues and descriptions have but little weight with him, and the work of the salesman is usually wasted, if the articles themselves are not shown. This fact is well understood by England and Germany hence they have established in the principal cities of the empire local exhibition rooms and offices, where the principal articles of manufacture are on exhibition—not for sale, but as samples. These show-rooms are in charge of competent engineers, usually of Russian nationality, familiar with local methods and ready to assist and advise the customer.

Of late there has been developed a tendency toward specialization, and where formerly all kinds of goods were found in one place, now separate exhibitions are made; some consist entirely of electrical apparatus, others of machine tools, and still others of agricultural machinery.

It is evident that such compliance with the business methods of the country must draw the larger portion of the trade to the nations which have had the good sense to grasp the situation, and it is foolishness for France, or the United States, or any other nation, to expect to capture much business without adopting the same system and giving the same opportunity for the machines to be examined and appreciated. In this instance at least the old maxim certainly holds good: "Well displayed is half sold."

Electric Tramways in Germany.

THE *Elektrotechnische Zeitschrift* publishes at the beginning of the year very full statistics of the electric tramways in Germany, brought down to September 1, 1897, showing the rapid growth of electric traction in that country. At the close of 1891 but three towns had electric traction in use, while in 1897 the number had grown to 56, and 34 additional cities had definitely decided to adopt electricity for tramway service. Of these 34 it was expected that 8 would be in operation before the end of 1897, so that the total number of cities using electric traction at the beginning of the present year is 64. The existing roads have more than 600 miles of track, of which about one-half is double; and, with the exception of 11 miles of underground road in Berlin, and less than 75 miles of storage-battery system, this is all overhead trolley.

THE ENGINEERING INDEX

INTRODUCTORY

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila., Pa.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Journal. *m.* London
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg- und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m.* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc of S. Africa. *m.* Johannesburg, S. A. R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.

Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* New York
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York
Engineering Magazine. *m.* London & New York
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glasers Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades' Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q* New London, Conn.
Journal Political Economy. *q.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kan.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London
McClure's Magazine. *m* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal
Mining Industry and Review. *w.* Denver, Col.
Mining Journal. *w.* London.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *q.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York
Revue de Mécanique. *m.* Paris.
Revue Technique. *b-m.* Paris.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerisches Bauzeitung. *w.* Zurich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York
Scientific Am. Supplement. *w.* New York
Scientific Machinist. *s-m.* Cleveland Ohio.
Scribner's Magazine. *m.* New York
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill
Street Railway Journal. *m.* New York
Street Railway Review. *m.* Chicago, Ill
Technology Quarterly. Boston, Mass.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York
Trans Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill
Western Railway Club, Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Zeitschrift für Lokomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.
Zeitschrift für Instrumentenkunde. *m.* Berlin.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

American Design.

The Tendency of American Design as Exemplified in Recent Buildings. Robert D. Andrews. Comments on classes and types of design. The conspicuous growth of the "classic style" in recent buildings. The Gothic style for cathedrals is largely favored. 2500 w. Arch Rev—Vol. IV. No. VIII. No. 17542 F.

Apartments.

Mechanical Features of the Lenox Apartments, Buffalo, N. Y. The building contains 49 apartments, and is supplied with heat, light and power, and with cold brine circulated through pipes to refrigerating boxes in the kitchens. 1800 w. Eng Rec—Jan. 1, 1898. No. 17510.

Brickwork.

See Civil Engineering, Miscellany.

Church.

The Evangelical Garrison Church at Strasburg. (Die Neue Evangelische Garnison-Kirche zu Strassburg.) Elevation, plans and section of this fine modern example of Gothic church architecture. 2000 w. 1 plate. Deutsche Bauzeitung—Jan. 8, 1898. No. 17843 B.

City Construction.

The City of the Future. Theodore Waters, in *Star Sayings*, St. Louis. On the engineering skill needed by architects of the present, in constructing the tall buildings of cities, especially in foundation work. The testing of grounds, weighing of buildings, &c., is considered. 2200 w. Stone—Jan., 1898. No. 17961 C.

Congressional Library.

The New Library of Congress. Russell Sturgis. An interesting study of the decorative work with brief history of the building, its architecture and plan. Ill. 8700 w. Arch Rec—Jan.-March, 1898. No. 18019 C.

Decoration.

House Decoration. L. A. Shruffrey. Read before the Architectural Assn., England. On the preparation of surfaces, exterior and interior; woodwork, walls, wall-papers. The treatment of natural woods; the deciding on decorations for various rooms, &c. Discussion follows. 10500 w. Builder—Dec. 25, 1897. No. 17590 A.

Domes.

Steel Domes of the Parrott Building and the City Hall at San Francisco, Cal. Illustrated description of the construction giving the general arrangement and construction of the various members. 1600 w. Eng News—Jan. 6, 1898. No. 17572.

Foundations.

The Foundations of the New Post-Office and Government Building at Chicago. Describes the work of building foundations, carried down through the clay to hard material, for this massive and heavy masonry structure. Ill. 2400 w. Eng News—Jan. 27, 1898. No. 18033.

Grain Elevator.

See Electrical Engineering, Power.

Iron Protection.

See Civil Engineering, Miscellany.

Mortar.

See Civil Engineering, Miscellany.

Mural Painting.

Mural Decoration. G. A. Reid. Briefly reviews the past history of wall decoration, and discusses some of the recent work in various lands, and the modern method of decoration. Ill. 2700 w. Can Arch—Jan, 1898. No. 17985 C.

Museum.

The Historical Museum at Berne. (Das Historische Museum in Bern.) Illustrated description of this fine new museum building in Switzerland, with plate of interior view. Two articles. 1500 w. Schweizerische Bauzeitung—Jan. 1, 8, 1898. No. 17838 E.

Roof Construction.

Notes on the Construction of the Weaving-Shed Roof. (Beitrag zur Konstruktion der Sägedacher.) Th. Landsberg. The trusses are united by jointed connection, to vertical frames forming a portion of the walls, or carried down within them. 1000 w. Zeitschr de Ver Deutscher Ing—Dec. 25, 1897. No. 17804 D.

Skeleton Construction.

The Use of Stone in Skeleton Construction. E. McL. Long. States the conditions to be fulfilled in the construction of these buildings, criticizing the deception in giving the building the appearance of solid masonry, and offering suggestions. Ill. 2700 w. Stone—Jan., 1898. No. 17960 C.

Structural Metals.

Effect of High Temperatures on the Strength of Structural Metals. H. K. Landis. The fire problem in steel skeleton buildings makes this a subject of importance. The article reviews tests made by competent authorities. 1100 w. Fire & Water—Jan. 22, 1898. No. 18011.

Tests.

Official Tests of Cast-Iron Columns and Brackets. Part first gives illustrated description of breaking columns through the body. 3000 w. Eng Rec—Jan. 8, 1898. Serial. 1st part. No. 17659.

Tests of the Strength of Brackets on Cast-Iron Columns. Summary of the results of bracket tests from the report of W. W. Ewing, with notes concerning the character of the fractures. 2300 w. Eng News—Jan. 20, 1898. No. 17943.

Theatre.

The Iron Reconstruction of the Variety Theatre at Prague. (Die Eisenconstruction des Variété-Theaters in Prag.) A valuable de-

scription of fireproof theatre construction, with details of iron work. 1800 w. Wiener Bauindustrie-Zeitung—Jan. 6, 1898. No. 17848 D.

Veneer.

Brick-Veneer Construction. Fred T. Hodgson. Discussion of this practice, showing that it is a loss both in economy and efficiency. 1200 w. Br Build—Jan., 1898. No. 18068 C.

HEATING AND VENTILATION.

Central Heating.

Examples of Small Central Heating and Ventilating Plants. (Beispiele Kleinerer Centralheizungs-und Ventilationsanlagen.) Showing large hot air furnace system for warming and ventilation, as applied to a theatre and a charitable institution near Vienna. 2500 w. Wiener Bauindustrie Zeitung—Dec. 23, 1897. No. 17847 D.

English Practice.

English Practice in the Warming and Ventilation of Technical and Art Schools. Paper prepared by Frank Ashwell and revised and edited by D. M. Nesbitt. Describes a mechanical system which is a combination of the plenum and vacuum systems, and discusses briefly the theory of the methods adopted. 7000 w. Trans Am Soc of Heat and Ven Engs—Jan., 1898. No. 18048 D.

Fans.

See Mining and Metallurgy, Mining.

Flues.

Draft Flues for Furnaces. E. C. Moses. Observations on the character of chimney flues, with general conclusions. 1100 w. Heat & Ven—Dec. 15, 1897. Serial. 1st part. No. 17491.

Forced Draft.

Heating and Ventilating Church and Parish Buildings by Forced Draft. B. H. Carpenter. States the conditions to be met and method of obtaining the required results. 1100 w. Trans Am Soc Heat & Ven Engs—Jan., 1898. No. 18047 D.

Gas Heating.

Heating with Gas. J. H. Kinealy. Gives a description of a grate and hot-air furnace, referred to in a paper by F. Foveaux, read before the Pacific Coast Gas Assn. Also quotes from a paper giving some results of experience with gas for heating schools in Germany. Ill. 1700 w. Met Work—Jan. 22, 1898. No. 17959.

Great Britain.

Heating in Great Britain. J. L. Saunders. Comment on the different conditions in the United States and Great Britain, with short account of systems most used. 1400 w. Heat & Ven—Dec. 15, 1897. No. 17492.

Hot Water.

The Hot-Water System for the Heating of Buildings. J. J. Blackmore. Illustrating and describing various systems of piping, boilers and radiators, with regard to the various adaptations to house heating, with data about proportions and performance. 4000 w. Engineering Magazine—February, 1898. No. 18082 B.

Humidity.

The Arid Atmosphere of our Houses in Winter. Henry Barnes. Abstract of paper read before the American Public Health Assn., at Philadelphia meeting. Compares the atmosphere of heated houses with the natural atmosphere, and discusses means for increasing the humidity. 1500 w. Heat & Ven—Dec. 15, 1897. No. 17493.

Old Methods.

Methods of Heating in Olden Time. Sidney Perley. Historical account of early fireplaces and stoves used in various places. 2800 w. Dom Engng—Jan., 1898. No. 17919 C.

Opera House.

Heating Installation in Cazenovia Opera House. Illustrated description of heating and ventilating plant. Direct-indirect radiators. 500 w. Heat & Ven—Dec. 15, 1897. No. 17494.

Pipes.

Proportioning of Circulating Pipes for Steam and Hot-Water Heating Systems. J. J. Blackmore. Examines the rules formulated by different engineers, showing their discrepancies and presents rules which the writer believes will establish safe ratios for all sizes of plants. 2400 w. Trans Am Soc of Heat & Ven Engs—Jan., 1898. No. 18051 D.

Radiators.

A New Type of Hot-Blast Radiator. George I. Rockwood. Describes a new type of radiator designed to produce a forced circulation of steam, and chiefly advantageous to use with steam of low or atmospheric pressure. Ill. 2300 w. Trans Am Soc Heat & Ven Engs—Jan., 1898. No. 18045 D.

Steam Circulation.

Some Experiments in Steam Circulation. John Gormly. Describes the peculiar behavior of the water line, investigations to ascertain the cause, and final remedy. 1000 w. Trans Am Soc of Heat & Ven Engs—Jan., 1898. No. 18046 D.

Steam Heating.

Single Pipe Low Pressure Steam Heating Systems. Mark Dean. Discusses the circuit system giving the requirements of the steam mains and branches, with rules, but emphasizing the need of common sense in the engineer to meet the varying conditions. 1400 w. Trans Am Soc of Heat & Ven Engs—Jan., 1898. No. 18050 D.

Steam Heating of the Buildings and Offices of the Administration of the International Exhibition of 1900, Paris. G. Debesson. States the conditions required, and gives illustrated description with costs. 1000 w. Heat & Ven—Dec. 15, 1897. No. 17490.

Temperature Recorder.

The Beraneck Temperature Recorder. (Der Wärmeschreiber, System Beraneck.) A revolving drum receives the electrically transmitted indications from any desired number of distant thermometers. 1200 w. Gesundheits-Ingenieur —Dec. 31, 1897. No. 17844 B.

Test.

A Test of the Heating and Ventilating Plant, New York State Veterinary College, Cornell University, Ithaca, N. Y. R. C. Carpenter. Gives description of buildings and plant, with report of investigations made and results. The fan system is used controlled by thermostats. Ill. 11500 w. Trans Am Soc of Heat & Ven Engs—Jan., 1898. No. 18044 D.

Ventilation.

Ventilation Practically Considered. Rufus R. Wade. Abridged from a work published for private distribution. Discusses the methods under the heads of natural, mechanical, and by aspiration. 2800 w. San Plumb—Jan. 1, 1898. No. 17554.

Walls.

The Effect of the Heights of Walls on the Amounts of Heat Transmitted Through Them. J. H. Kinealy. Reviews the experiments made by other investigators and holds that the heat loss of a high wall is greater than that of a lower one of the same kind, area and thickness. 1800 w. Trans Am Soc of Heat & Ven Engs—Jan. 1898. No. 18049 D.

LANDSCAPE GARDENING.

Forestry.

See Municipal Engineering, Water Supply.

Landscape.

The Imaginative Element in Landscape. Sylvester Baxter. Some thoughts on this subject as applied to park development. 2200 w. Am Arch—Jan. 8, 1898. No. 17624.

PLUMBING AND GASFITTING.

Hotel.

Plumbing in the Astoria Hotel. Part first gives general description of the building and outline of water supply and drainage systems. Ill. 2200 w. Eng Rec—Jan. 22, 1898. Serial. 1st part. No. 17965.

Hot-Water Supply.

Mistakes Made in the Erection of Domestic Hot-Water Supply Apparatus. Frederick Dye. Part first discusses English practice, giving instances of bad results due to details of construction. Ill. 2000 w. Heat & Ven—Dec. 15, 1897. Serial. 1st part. No 17495.

On Heating Water by Steam. Discusses the best means of heating water for use in industrial establishments, and gives rule for finding the weight of steam required to heat a given body of water to the boiling point. 1500 w. Prac Eng—Dec. 31, 1897. No. 17697 A.

Regulations.

Plumbing Regulations of Moline, Ill. A copy of these regulations which are considered in many respects a model. 5400 w. Eng Rec—Jan. 15, 1898. No. 17767.

Ventilation.

Sewer Ventilation. J. W. Hughes. Opposes the use of the intercepting trap, giving reasons. 1400 w. Dom Engng—Jan., 1898. No. 17918 C.

MISCELLANY.

Ancient Buildings.

Shetland Brochs. Describes the structure and interior arrangement of the Broch of Mousa, one of a class of ancient buildings on this island. 2300 w. Arch, Lond—Dec. 31, 1897. No. 17682 A.

Building Laws.

The Enforcement of Building Laws. Osborne Howes. Read before the Detroit convention of Building Commissioners and Inspectors. Suggests that the board of underwriters of a city impose a penal charge of double rates upon buildings put up in defiance of a building law. 900 w. Arch & Build—Jan. 15, 1898. No. 17740.

Cast-Iron Columns.

The Strength of Cast-Iron Columns. Editorial on the importance of the experiments made by the New York Building Department upon the large testing machine at Phœnixville, Pa. The results show the worthlessness of Gordon's formula as applied to cast iron columns. 2300 w. Eng News—Jan. 20, 1898. No. 17944.

Cement.

See Civil Engineering, Miscellany.

Competitions.

The Lesson of the Pennsylvania Capitol Competition. William Seton Gordon. A review of the facts with the view of discovering what practical conclusions may be drawn for future guidance. 4500 w. Eng Rec—Jan. 1, 1898. No. 17509.

Edinburgh.

The Architecture of Our Large Provincial Towns — Edinburgh. Interesting historical account with illustrated descriptions of old and new architecture. 9500 w. Builder—Jan. 1, 1898. No. 17679 A.

Education.

The True Education of an Architect. Russell Sturgis. The importance of teaching young architects to build, to draw, to model, 6800 w. Atlantic M—Jan., 1898. No. 17979 D.

Elevators.

See Mechanical Engineering, Miscellany.

Lathe Work.

Lathe Work in Interior Decoration. Fred T. Hodgson. Showing how lathe work may be effectively applied to interior finishing. Ill. 1400 w. Can Arch—Jan., 1898. No. 17986 C.

Leaded Glass.

Architectural Sympathy in Leaded Glass. Otto Heinigke. On the faults of stained-glass windows, and the need of the architect, and the study of architectural effect. Ill. 3000 w. Arch Rev—Vol. IV—No. VIII. No. 17541 F.

London Fire.

The Cripplegate Fire. Reports the evidence of the witnesses of the architectural profession regarding the class of buildings, and the use to which they were put, fire protection needed, &c. 5800 w. Engng—Dec. 24, 1897. No. 17607 A.

Melrose.

Melrose Abbey. W. J. Anderson. Illustrated description of this well-known Scottish ruin. 6000 w. Builder—Jan. 1, 1898. No. 17681 A.

Palladio.

Palladio and His Work. Alfredo Melani. Historical account of what is known of this great architect of the sixteenth century, his work and his influence. Ill. 4800 w. Arch Rec—Jan.-March, 1898. Serial. 1st part. No. 18017 C.

Pisa Tower.

The Problem of the Leaning Tower of Pisa. William H. Goodyear. A study of leaning buildings of Italy, the façade of the Cathedral, the tower, and other structures, aiming to give a solution of the problem of construction. Ill. 8500 w. Arch Rec—Jan.-March, 1898. No. 18018 C.

Report.

Report of the Committee on Architecture and Grounds of the Tennessee Centennial Exposition. Extract from the report, containing intelligent criticism of the architectural work. Ill. 3300 w. Br Build—Jan., 1898. No. 18067 C.

Roofs.

Thatched Roofs. Henry Rose. Statistics show that this form of roofing is falling into disuse, but it is still common in country districts. Methods of laying it are given, with its advantages and disadvantages, and its æsthetic qualities. 2300 w. Builder—Jan. 1, 1898. No. 17680 A.

Sanitation.

See Municipal Engineering, Sewerage.

School Buildings.

The School Buildings of New York. John Beverley Robinson. A finely illustrated article on the school buildings of New York, showing the great improvements made, and the evidences of careful thought. 5000 w. Arch Rec—Jan.-March, 1898. No. 18020 C.

Sculpture.

The Angels at Bradford-on-Avon, Wilts, Eng. S. Beale. Describes these examples of early sculpture, and refers to the use made by architects of the forms of angels, because of the ease with which they may be adapted to awkward spaces. Ill. 1500 w. Am Arch—Jan. 22, 1898. No. 17980.

The Sculpture for the Glasgow Art Galleries. Gives the report of the architects and master sculptor on the sculpture and carving, with favorable comment. 5500 w. Brit Arch—Dec. 24, 1897. No. 17614 A.

Tombs.

The Tomb of a Theban Astrologer of the Eighteenth Dynasty. P. Hippolyte-Boussac. Printed in both English and French. Illustrated description of an ancient tomb, especially the paintings which decorate it. 1600 w. Jour Roy Inst of Brit Arctrs—Dec. 4, 1897. No. 17741 B.

Wire Nails.

See Mechanical Engineering, Miscellany.

Woman's Influence.

Influence of Women on Architecture. C. T. Mathews. Reviews noted instances in history where the influence of women has been the inspiration or power that resulted in fine architectural work. 2000 w. Am Arch—Jan. 1, 1898. No. 17560.

CIVIL ENGINEERING.

BRIDGES.

Arches.

Stone Arches of Large Span with Articulated Joints of Lead. An account of some arched bridges built in Wurtemburg by M. Liebbrand, employing lead in the key joints and joints of rupture, with satisfactory results. 800 w. Eng News—Jan. 20, 1898. No. 17947.

Berne.

The Competition for the Lorraine Bridge at Berne. (Concurrenz-Entwurf für die Lorraine-Brücke in Bern.) Devoted especially to an examination of the design which contained a wide span arch of iron and concrete, and which although not finally adopted, received an award. 8000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17818 D.

Brooklyn Bridge.

Strength of the New York and Brooklyn Suspension Bridge. Brief discussion as to the increased loads being a cause of danger. 1000 w. Sci Am—Jan. 8, 1898. No. 17555.

Cantilever.

The Cachoeira Bridge, Brazil. Illustrated description of a steel cantilever bridge recently built, especially some of the features adapted to local conditions in which the English methods of work differ from the usual practice in the United States. 1800 w. Eng Rec—Jan. 1, 1898. No. 17503.

Continuous Girder.

The Continuous Arched Girder with Two Joints. (Der Continuierliche Bogenträger mit Zwei Gelenken.) A very full mathematical discussion, with the practical example of the bridge over the Rhine at Constance fully computed. 8000 w. 1 Plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17820 D.

East River.

Bridges Over the East River. O. F. Nichols. Read before the Municipal Club of Brooklyn, Jan. 18, 1898. Considers the old bridge, the new bridge, and the next bridge, pointing out what is needed to insure the greatest benefits. 2700 w. Eng Rec—Jan. 22, 1898. No. 17963.

Viaduct.

Competitive Designs for Connecticut Avenue Viaduct, Washington, D. C. A brief statement of conditions governing the work, with illustrated descriptions of designs submitted. 2500 w. Eng News—Jan 27, 1898. No. 18029.

The Riverside Drive Bridge. A New York highway bridge, 1564 feet long, with a 60-ft. carriage-way, and two ten-ft. sidewalks. The bridge consists of 25 arch-spans in which particular attention was paid to harmonious outlines. 1000 w. Eng Rec—Jan. 8, 1898. No. 17654.

CANALS, RIVERS AND HARBORS.

Bohemia.

The Status of the Work on the Moldau-Elbe Canal in Bohemia. (Ueber den Stand der Canalisierungs-Arbeiten an der Moldau und Elbe in Böhmen) With photographs of various sections, and a plate of weir buildings; together with a record of the variations in level of the Moldau at Prague during 1897. 6000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17816 D.

Breakwaters.

Breakwater Construction on the American Coast. Louis Y. Schermerhorn. Confined to the construction on the ocean coast and considering the forces through wave action, design, position and general principles; also discussion. Ill. 7500 w. Pro of Engs' Club of Phila—Jan., 1898. No. 17611 D.

Dortmund.

General Meeting of the Society for the Construction of a Canal from Dortmund to the Rhine. (General Versammlung des Vereins für Erbauung eines Kanals von Dortmund nach dem Rhein.) The construction of the canal was strongly urged, and the inadequacy of the existing railway facilities shown. 8000 w. 4 plates. Glückauf—Dec. 18, 1897. No. 17849 B.

Floods.

Mississippi Floods. W. W. Knight. States the conditions that exist along this river, reviewing the work that has been done, and the plans proposed, with brief account of damages. 2000 w. Yale Sci M—Dec., 1897. No 17545 C.

Harbor Improvement.

Harbors and Waterways. Editorial discussion of improvements made and planned, made necessary by the constantly increasing size of vessels; also inland navigation and related matters. 4300 w. Engr, Lond—Jan 7, 1898. No. 17902 A.

Wharf Improvement and Harbor Facilities. (Outillage et Aménagement des Ports.) A condensed abstract and translation of Mr. Crowell's article in *The Engineering Magazine* of November, 1897. 2500 w. La Revue Technique—Jan. 10, 1898. No. 17823 D.

Jetties.

The Great Training Jetty at the Mouth of the Columbia River, Oregon. Illustrated description of this very successful engineering work. 1700 w. Sci Am—Jan. 15, 1898. No. 17780.

Levees.

Standard Levee Sections. H. St. L. Coppée. Explains the work along the Mississippi and the standards adopted in the various sections. Also gives comparison of the third district levee section with the old American notions and with those used in foreign countries, in order to determine what evolution there has been, and how the practice in various places compares. Tabulated results and many illustrations. 4000 w. Pro Am Soc of Civ Engs—Jan., 1898. No. 18052 F.

Loire.

The Navigation of the Loire. (La Loire Navigable.) An appeal for river improvements in aid of the navigation of the Loire, citing the important commercial and manufacturing interests of France affected thereby. 3500 w. La Revue Technique—Jan. 10, 1898. No. 17824 D.

New York Canals.

Concerning Erie Canal Improvements. Chauncey N. Dutton. Letter offering comments on an editorial on this subject, published in the Jan. 6 issue of this journal, and giving opinions of the writer. 4500 w. Eng News—Jan. 27, 1898. No 18031.

New York's Canal Improvement. Full report of C. W. Adams, State Engineer and G. W. Aldridge, Superintendent of Public Works. Statements concerning work in progress and projected, cost, &c. 11000 w. Sea—Dec. 30, 1897. No. 17489.

Present Status of the New York State Canals Improvements. Statements relating to the progress and cost of the work, from the report of Campbell W. Adams, State engineer of New York, with editorial notes. 2000 w. Eng News—Dec. 30, 1897. No. 17481.

The New York State Canals. Editorial comment on recent developments concerning the estimates of cost of proposed improvements. 1600 w. R R Gaz—Jan. 7. 1898. No. 17565.

What Shall New York Do with its Canals? Editorial discussion of the present situation and the best course to pursue. 2700 w. Eng News—Jan. 6, 1898. No. 17573.

River Regulation.

Notes on the Regulation of Rivers with Shifting Channels. (Beitrag zur Frage der Regulierung Geschiebeführender Flüsse.) R. Iszkowiski. Discussing the especial question of the practicability of straightening winding river courses and recovering the land for agricultural purposes. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17819 D.

The Regulation of the Theiss in the Bodrogközer District. (Die Bodrogközer Theiss-Regulierung.) Describing the river improvements intended to prevent the disastrous inundations of an important agricultural district of Hungary by the river Theiss. 3000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Jan., 1898. No. 17817 D.

Seaports.

Our Future Seaports. Archibald A. Schenck. Some information regarding important ports of the United States, and the concessions being made by railroads to reach these ports directly at the coast. 600 w. R R Gaz—Jan. 21, 1898. No. 17957.

Ship Canals.

The Economic Effects of Ship Canals. J. A. Fairlie. Traces the economic effects, showing how, in consequence of the canals, important changes have been made in business machinery, in business methods, in producing and market-

ing commodities, and in general economic development. 7500 w. An Am Acad—Jan., 1898. No. 17529 G.

Tidal Deposits.

The Tidal Marshes of the Bay of Fundy. Describes the action of the tides which have formed the salt marshes of New runswick and Nova Scotia. 2000 w. Eng News—Dec. 30, 1897. No. 17477.

IRRIGATION.

Colorado.

Peculiar Features of Irrigation Engineering in Colorado. H. A. Crafts. A fully illustrated account of irrigation methods in Colorado with details of ditch construction and data as to cost, capacity, and operation. 3500 w. Engineering Magazine—February, 1898. No. 18083 B.

Dam.

California's Big Dam. Helen H. Gardener. Interesting information and popular account of the great Morena Dam, near San Diego, and its construction. 2500 w. Harper's Wk—Jan. 8, 1898. No. 17578.

Falling Shutters.

Falling Shutters, Godavery Anicut. J. C. Larminie. Describes the falling shutters substituted in lieu of a permanent raising of the Anicut by two feet. Ill. 600 w. Ind Engng—Dec. 18,1897. No. 17924 D.

Progress.

Recent Progress in Irrigation. F. H. Newell. Read at Irrigation Congress, at Lincoln, Neb. Recent development has been along the line of increase of area cultivated. Very few large systems have been constructed. The small works have usually been successful. Discusses why large corporate enterprises often fail. 2800 w. National Advocate (San Francisco)—Dec., 1897. No. 17987.

MISCELLANY.

Bending.

The Stresses in Stone or Concrete Plates Subjected to Bending. (Die Spannungen in auf Biegung Beanspruchten Stein- oder Betonplatten.) A mathematical investigation by Prof. Hofmann, with application to practical examples. 1000 w. Deutsche Bauzeitung—Dec. 22, 1897. No. 17842 B.

Brickwork.

Brickwork Tests. Report on the Third Series of Experiments by William C. Street and Max Clarke, with Appendices by Professor Unwin. Tabulated results are given with other information of interest. 6000 w. Jour Roy Inst of Brit Archs—Dec. 18,1897. No. 18001 B.

Cement.

The Chemical Constitution of Portland Cement. On the experiments of Messrs. S. B. and W. B. Newberry, giving conclusions and comparing them with conclusions reached by Le Chatelier. 1800 w. Engr, Lond—Dec. 24, 1897. No. 17592 A.

Drainage.

Benefits of Tile Drainage. E. M. Pike. Read at meeting of Illinois Clay Workers Assn. Sets forth the advantages of tiling and explains how it improves the condition of the soil. 1800 w. Brick—Jan., 1898. No. 17724.

The Drainage Works in the Delta of the Niemen. (Die Schöpfwerke im Memel-Delta.) Describes the use of electric power to recover a large tract of land at the mouth of the Niemen. The first installment contains an account of the central electric station. Serial. Part 1. 2000 w. Der Elektro Techniker—Dec. 31, 1897. No. 17879 B.

Earthwork.

Some Practical Applications of the Mass Curve in Earthwork Computations. Walter L. Webb. Reviews the fundamental features of this method for the computation of earthwork, with applications of the curve. Discussion. Ill. 5800 w. Pro of Engs' Club of Phila—Jan., 1898. No. 17613 E.

Iron Protection.

Paints for the Protection of Iron Work. A. H. Sabin. Condensed from a lecture delivered before the students of the Rensselaer Polytechnic Inst. Shows the danger from rust, discusses the treatment necessary, giving directions and suggestions. 2800 w. Eng News—Jan. 27, 1898. No. 18035.

The Preservation of Iron from Rust. Discusses whether there is any need for the use of mixtures containing pigments or linseed oil. Shows the pigment possesses no protective value, and calls attention to tar, pitch and asphaltum as rust preventers. 4000 w. Engr, Lond—Jan. 14, 1898. No. 17988 A.

Library.

An Opportunity for the American Society of Civil Engineers. Editorial. Suggests that an extension should be made to the scope and usefulness of the Society's library, making it of great value to the engineering profession. 1600 w. Eng News—Jan. 13, 1898. No. 17716.

Monier System.

The Influence of Temperature Changes on Concrete-Iron Constructions. (Einfluss von Temperaturschwankungen auf Beton-Eisenconstructionen.) J. Hermanek. A mathematical discussion, showing that no injurious stresses are likely to occur from expansion and contraction of the metallic portion of work executed in the Monier system of concrete and iron. 1000 w. Zeitschr d Oester Ing u Arch Ver—Dec. 17, 1897. No. 17810 B.

Mortar.

Study of the Ultimate Constitution of Hydraulic Mortar (Etudes sur la Constitution Intime des Mortiers Hydrauliques.) R. Feret. An account of tests of Portland cement mortars, showing the importance of using fine sand and securing thorough admixture. Compression tests are considered most reliable. 20000 w. Bulletin de la Société d'Encour—Dec., 1897. No. 17835 G.

Quarry.

The Quarries of St. Triphon. (Les Carrières de St. Triphon.) Description of marble quarries in the Rhône valley in Switzerland, with an

account of the use of the endless wire saw, and electric traveling crane. 1500 w. Schweizersche Bauzeitung—Jan. 1, 1898. No. 17839 B.

Review.

Civil Engineering. Editorial review of the outlook for this profession in England, and the work of the past year. Also considers work to be done in other lands. 5800 w. Engr, Lond—Jan. 7, 1898. No. 17900 A.

Roads.

Some Considerations About Roads. N. S. Frost. Extracts from a paper read at a recent meeting at Petaluma, Cal. On the direction of roads, grades, drainage and surface. 1500 w. Min & Sci Pr—Jan. 8, 1898. No. 17739.

Some Features of Stone Road Construction. Benjamin Franklin. Discusses (1) The use of clay or loam as a "binder" on stone roads; (2) The thickness of stone roads; (3) The comparative merits of Macadam and Telford roads. Also followed by general discussion. 8300 w. Pro of Engs' Club of Phila—Jan., 1898. No. 17-612 D.

Proposed Road Through the Sty Head Pass. An account of a new coaching road to be built from Borrowdale to Wasdale, England, which will open up some of the finest scenery of the Lake District. 1200 w. Engr, Lond—Dec. 31, 1897. No. 17694 A.

Roof Construction.

See Architecture & Building, Construction.

Search Light.

A Portable Search-Light Apparatus. (Projecteur Lumineux Portatif.) A small sphere of platinum in the focus of a parabolic reflector is raised to white incandescence by the blast of a hydrocarbon vapor. The apparatus is especially applicable to military, mining, and engineering work. 1000 w. La Revue Technique—Jan. 10, 1898. No. 17826 D.

Spirit Leveling.

Spirit Leveling of the United States Geological Survey. Herbert M. Wilson. A statement of the work of the field parties engaged in the topographic mapping of the United States Geological Survey, in the careful spirit-leveling conducted by them. 15000 w. Pro Am Soc of Civ Engs—Jan., 1898. No. 18053 F.

Structural Metals.

See Architecture & Building, Construction.

Tests.

See Architecture & Building, Construction.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Africa.

Trading Stations of the West Coast of Africa. Summary of information regarding some of the trading stations in French and Portuguese Congo on the West Coast of Africa. 1600 w. Bd of Tr Jour—Jan., 1898. No. 18061 A.

Asiatic Trade.

America's Opportunity in Asia. Charles Denby, Jr. Calls attention to the possibilities, aiming to arouse interest and to point out measures which would benefit United States exporters. Considers that we have all the advantages and need only to act. 3000 w. N Am Rev—Jan., 1898. No. 17533 D.

Bohemian Exports.

Bohemian Exports to the United States. Some points of interest to American manufacturers, giving brief suggestions concerning the introduction of American goods, and other information. 1100 w. Cons Repts—Jan. 27, 1898. No. 18043 D.

British Columbia.

British Columbian Laws as to Trading Corporations. A summary of the provisions in regard to extraprovincial companies. 600 w. Cons Repts—Jan. 4, 1898. No. 17580 D.

The Trade and Industry of British Columbia. Information from the annual report of the British Columbia Board of Trade, about mining, fisheries, sealing, lumber, agriculture, etc. 1200 w. Bd of Tr Jour—Jan., 1897. No. 18063 A.

British Trade.

Present Condition of British Trade. Commenting on the unfortunate conditions affecting the trade and quoting from articles published in British papers. 2800 w. Cons Repts—Jan., 1898. No. 17734 D.

China.

German Occupation of Chinese Territory. Discusses the resources of the region and the possibilities for United States trade. 1500 w. Cons Repts—Jan. 13, 1898. No. 17730 D.

Commercial School.

Commercial High School for Magdeburg. Reports the steps being taken in Germany, to advance the higher education of the merchant class in branches of their occupation. It is proposed to establish a state commercial high-school at Magdeburg, Prussia. 1200 w. Cons Repts—Jan. 15, 1898. No. 17752 D.

Competition.

American Competition in Europe. A review of the progress of American trade, and of special branches that have undertaken to supply the demand, with discussion of the effects, and the means of advancing American interests. 3200 w. Cons Repts—Jan. 18, 1898. No. 17912 D.

American Competition in the World's Iron Trade. Richard Moldenke. Condensed translation of address of E. Schroedter, discussing the growth of the American iron production and the invasion of foreign markets, with brief comments. 2700 w. Ir Trd Rev—Jan. 6, 1898. No. 17620.

Future Supremacy in the Iron Markets of the World. J. Stephen Jeans. In this paper Mr. Jeans discusses the conditions affecting the eco-

nomical value of finished products in different countries. The prediction is made that the United States will become a larger seller and smaller buyer and ultimately become the richest country in the world. 5000 w. Engineering Magazine—February, 1898. No. 18084 B.

Duties.

Peruvian Duties Payable in Gold. Translated copies of a law providing for the payment of duties in pounds sterling, gold. 600 w. Cons Repts—Jan. 7, 1898. No. 17584 D.

Export Trade.

Charles Davis on Developing an Export Trade. From a paper read at a complimentary dinner at the Manufacturers' Club of Cincinnati. Points out the defects of the United States trade, discussing the subject under heads of politics and business, a foreign commercial policy, over confidence, trading and exporting companies, the consular service, foreign languages, and lack of commercial marine. 3000 w. Ir Age—Jan. 20, 1898. No. 17939.

Failures.

Failure Statistics and Their Meaning. Tabulated statistics of failures classified for use, with explanation of work done by the Bradstreet Co., and its value. 7500 w. Bradstreet's—Jan. 22, 1898. No. 17973.

Germany.

Industrial Advance in Germany. Michael G. Mulhall. Considers the development of the last 20 years, the increase in population and energy; the agriculture, forestry, manufactures, hardware, sugar, mining, shipping, railways, and banking; the wealth and finances; attributing all to the advanced state of instruction in every part of the empire and among all classes of people. 3500 w. N Am Rev—Jan., 1898. No. 17534 D.

India.

False Trade Descriptions in India. Report of fraudulent importations. 2000 w. Bd of Trd Jour—Jan., 1898. No. 18062 A.

Interstate Commerce.

See Railroad Affairs, Transportation.

Japan.

Japan's Trade. Information from the report of Byron Brenan, issued by the English Foreign Office, with suggestions for extending British trade. 4500 w. Ind & Ir—Dec. 31, 1897. No. 17683 A.

The Industrial Movement in Japan. Caspar Whitney. General remarks on the activity and achievements of the past 25 years. Ill. 2000 w. Harper's Wk—Jan. 8, 1898. No. 17579.

Kongo Free State.

Trade Regulations and Taxes in the Kongo Free State. A summary of the condition of affairs governing trade at the present day. Cons Repts—Jan. 19, 1898. No. 17910 D.

Petroleum.

Russia's Petroleum Export to Germany and Austria-Hungary, and New Caucasian Oil Fields. F. Thiess. Translation from the German. Shows that Germany imports almost exclusively from the United States, and states that Russian oil men are making every effort to secure this market for their products. Gives information of new oil discoveries. 500 w. Am Mfr & Ir Wld—Dec. 31, 1897. No. 17500.

Prices.

Comparative Prices of 108 Staple Articles, Raw and Manufactured Products, Produce, Cattle and Meats. Tabulated information showing fluctuations in quotations from October 1, 1894, to January 1, 1898. 2500 w. Bradstreet's—Jan. 15, 1898. No. 17745.

Review.

Encouraging Results of the Business Year. Review of the year 1897, showing it to have been quite satisfactory. A larger aggregate of business in the country as a whole than any year since 1892. Detailed reports of the year's trade in the leading cities of the United States are given. 6000 w. Bradstreet's—Jan. 1, 1898. No. 17499.

Rubber.

Higher Prices for Mechanical Rubber Goods. Reports a resolution passed by the Mechanical Rubber Mfrs. Assn., ordering an advance of 10% on special and listed rubber goods and cotton hose. 1400 w. Ind Rub Wld—Dec. 10, 1897. No. 17537 D.

Importations of India-Rubber During 1897, in Tons. Tabulated statement from advance sheets furnished by Henry A. Gould & Co., of New York. 200 w. Ind Rub Wld—Jan. 10, 1898. No. 17968 D.

Official Statistics of India-Rubber and Gutta Percha. Tabulated statements of imports and exports for the year ending June 30, 1897. 900 w. Ind Rub Wld—Jan. 10, 1898. No. 17967 D.

Tea.

Tea Trade of Formosa. Information regarding this subject with review of the season of 1897. 2000 w. Cons Repts—Jan. 6, 1898. No. 17623 D.

Technical Schools.

Technical Merchant Schools. On the efforts being made in Germany to improve the business education of the people, giving extracts from article published in the *London Standard*. 2000 w. Cons Repts—Jan., 1898. No. 17736 D.

Trade-Marks.

Labels and Trade-Marks in China. An explanation of the importance of trade-marks, especially in China, where the superstitions of the people are often offended by the design or color. 1000 w. Cons Repts—Jan. 11, 1898. No. 17622 D.

United States.

Commercial Superiority of the United States. Worthington C. Ford. A protest against the usual method of obtaining commercial statistics, and showing the advantage possessed by the United States by reason of its agriculture, with discussion of other points of importance. 3300 w. N Am Rev—Jan., 1898. No. 17535 D.

Venezuela.

Venezuelan Laws as to Transit Traffic with

Colombia. Substance of the laws in regard to goods shipped in transit to Colombian ports. 2200 w. Cons Repts—Jan. 5, 1898. No. 17581.

Yokohama.

The Trade of Yokohama in 1896. Digest of the report of the British consul concerning the extent and growth of the trade. 1900 w. Engng—Dec. 31, 1897. No. 17691 A.

CURRENCY AND FINANCE.

Currency Reform.

Plans for Currency Reform. Charles A. Conant. A comparison of President McKinley's plan for reform, the scheme of Secretary Gage, and the work of the monetary commission. 6000 w. Am Rev of Revs—Jan., 1898. No. 17569 C.

German Markets.

The Financial Markets of Germany. Raphael-Georges Levy. From the French *Revue des Deux Mondes*. Reviews the rapid progress in Germany, with the view of ascertaining the cause of her success, and how far her methods may be used under differing circumstances. 3000 w. Chau—Feb., 1898. No. 18025 C.

Metal Market.

See Mining and Metallurgy, Miscellany.

Monetary Commission.

Report of the Monetary Commission. An unabridged copy of the report giving a clear statement of existing financial conditions and the changes needed. 13000 w. Bankers' Mag, N. Y.—Jan., 1898. No. 17782 D.

The Report of the Monetary Commission. Report of the salient features of the plan of reform submitted. 3500 w. Ir Age—Jan. 6, 1898. No. 17577.

Russia.

Russia's Currency Reform. An account of the movement and the conditions leading to the establishment of the gold standard. 1000 w. Bradstreet's—Jan. 15, 1898. No. 17744.

Tariff.

Tariff Changes and Customs Regulations. Russia, Belgium, Germany, France, Portugal, Spain, Switzerland, United States, Mexico, Guatemala, Ecuador, Uruguay, Grenada and Cape Colony. 5000 w. Bd of Trd Jour—Jan., 1898. No. 18064 A.

GOVERNMENTAL CONTROL.

Child Labor.

The Illinois Child-Labor Law. Florence Kelley. Read before the International Assn. of Factory Inspectors, at Detroit. A statement of the present law in this state and the need of further legislation. 4800 w. Am Jour of Soc—Jan., 1898. No. 17763 D.

Municipal Ownership.

Objections to the Municipal Ownership of Public Works. T. Carpenter Smith. A discussion of this much-mooted question, especially in regard to the municipal ownership of electric-lighting plants, viewed from the standpoint of the electrical engineer, and taking the adverse position to city control. 4000 w. Engineering Magazine—February, 1898. No. 18079 B.

Ownership.

Government Ownership and Operation of Railroads. Extract from an open letter by E. P. Ripley discussing this question, and showing that private enterprise has proved more satisfactory. 2400 w. Ry & Engng Rev—Jan. 22, 1898. No. 18024.

LABOR.

Engineering Strike.

London Engineers' Dispute. The Strike for a Forty-eight Hours' Week. Address of Sir Benjamin Dobson, of Dobson and Barlow, on the question at issue, discussing various points claimed by the employers. 5500 w. Bos Jour of Com—Jan. 8, 1898. No. 17641.

The End of the Conference. Editorial discussion of the situation, and the rejection of the employers' second proposals. 2000 w. Engng—Dec. 31, 1897. No. 17690 A.

The Plevna of Labor. Anon. Reviews the various points under dispute in this struggle, and the changes that have developed in its progress. Generally in sympathy with the employés. 5300 w. Contemporary Rev—Jan., 1898. No. 17711 D.

Free Labor.

The Protection of Free Labor. Brief explanation of the object of the Free Labor Protection Assn., of England, and information concerning it. 700 w. Transport—Jan. 14, 1898. No. 18002 A.

Jewish Workman.

The Jewish Workman. John A. Dyche. A contribution to the subject of alien immigration, answering charges made against the Russian Jew. 7800 w. Contemporary Rev—Jan., 1898. No. 17710 D.

Machinery.

Labor-Saving Machinery. Thomas L. Wilkinson. A discussion of labor-saving machinery in reference to the displacement and expansion of labor, showing it to be mutually beneficial to labor and capital. 2500 w. Min Ind & Rev—Jan. 6, 1898. No. 17665.

Negro Labor.

The Labor Unions and the Negro. John Stephens Durham. The relations of the unions to the colored race are discussed, and the effect of the obstructions preventing its development. 6000 w. Atlantic M—Feb., 1898. No. 17978 D.

Ticket Brokerage.

See Railroad Affairs, Transportation.

Working Hours.

The Hours of Work of Women and Children. Florence Kelley. Reviews the position taken in various parts of the United States, showing that improvement is needed. 1400 w. Chau—Jan., 1898. No. 17498 C.

MISCELLANY.

Accidents.

Protection to Workingmen. (Arbeiterschutz.) A statistical report of the Journeymen's Association, giving much information as to the protection of workingmen in Germany against acci-

dental injury. Data are given up to 1897, with comparisons for the ten years between 1885 and 1895. 4000 w. Glaser's Annalen—Jan. 1, 1898. No. 17815 D.

Montreal.

Incomes, Wages, and Rents in Montreal. Herbert Brown Ames. Data concerning the industrial conditions of this city. 4800 w. Bul Dept of Labor—Jan., 1898. No. 18000 D.

Negro.

The Negroes of Farnsville, Virginia: A Social Study. W. E. Burghardt Du Bois. The first of a series of investigations of small, well-defined groups of negroes in various parts of the country, with the object of ascertaining their real condition. 13000 w. Bul Dept of Labor—Jan., 1898. No. 17999 D.

Patents.

Reforms in the Patent Laws. From report issued by a committee of the National Assn. of Mfrs. of the U. S. Part first considers annuities on U. S. patents; and requiring working and annuities from foreigners, with opinions from letters in relation to this subject. 3000 w. Ir Age—Jan. 13, 1898. Serial. 1st part. No. 17717.

Report.

President's Report to the Manufacturers' Association. Theodore C. Search. Extract dealing with exports, the shipping question, the Nicaragua Canal, the creation of a Department of Commerce and Industry, sample warehouses, &c. &c. 6800 w. Ir Age—Jan. 27, 1898. No. 18042.

ELECTRICAL ENGINEERING.

ELECTRO-CHEMISTRY.

Chlorine.

Chlorine from Electricity. A description of what is known as the Rhodin process, by which a saturated solution of common salt can be decomposed in such a manner that chlorine shall be given off at one pole, and sodium at the other. 1300 w. Aust Min Stand—Dec. 9, 1897. No. 17921 B.

Conductivity.

The Conductivity of Solutions of Certain Salts in Pyridin. (Leitfähigkeit von Lösungen einiger Salze in Pyridin.) Drs. Laszczynski and Gorski. Describing experiments on solutions of salts of potassium, sodium, lithium, &c., in pyridin, with notes on the results as to conductivity and decomposition. 1500 w. Zeitschr f Elektrochemie—Dec. 20, 1897. No. 17874 B.

Electrolysis.

Studies in the Electrolytic Separation of Metals. (Studien über die Electrolytische Trennung von Metallen.) N. Revay. Giving details of the separation, by electrolysis, of copper from silver, from mercury, and from arsenic. Serial. Part 1. 1800 w. Zeitschrift f Elektrochemie—Jan. 5, 1898. No. 17876 B.

The Electrolysis of Solutions of Common Salt. Reports the causes of different values reached in investigations made, as explained by Prof. Lorenz, of the Zurich Polytechnic in article published in the *Zeits. f. Elektrochemie.* 600 w. Elect'n, Lond—Dec. 31, 1897. No. 17678 A.

The Electrolytic Separation of Copper from the Group of Positive Metals. (Elektrolytische Scheidung des Kupfers von der Gruppe der Positiven Metalle.) Dr. B. Neumann. A discussion of the technical methods of separating copper from nickel, cobalt, iron and zinc by electrolysis. Serial. Part 1. 3000 w. Zeitschr f Elektrochemie—Jan. 5, 1898. No. 17877 B.

The Electrolytic Winning of Zinc. (Verfahren zur Electrolytischen Zinkgewinnung.) Dr. C. Hoepfner. Giving precautions and suggestions to aid in the application of the electrolytic separation of metallic zinc from the ore on a commercial scale. 1000 w. Der Elektro Techniker—Dec. 15, 1897. No. 17880 B.

LIGHTING.

Brooklyn.

The Edison Electric Illuminating Co. of Brooklyn—Its Development and Its Present and Future Work. Jos. Wetzler. History of the work and equipment of this company. Describes the older stations, and also this latest three-phase system and the great Union Station. Ill. and map. 7200 w. Elec Eng, N. Y.—Jan. 6, 1898. No. 17699.

Efficiency.

The Present Efficiency of Incandescent Lamps. John E. Randall. Read before the Northwestern Elec. Assn., at Milwaukee. Part first reviews tests made, and history of work done, and discusses the points on which the quality, as an illuminant, depends. 1200 w. Elec Wld—Jan. 29, 1898. Serial. 1st part. No. 18074.

Enclosed Arc.

Enclosed Arc Lamps. (Ueber Bogenlampen mit Eingeschlossenem Lichtbogen.) Describes photometric tests of the Jandus enclosed arc lamp, with curves of photometric intensity and tables of results. 7500 w. Elektrotech Zeitschr—Dec. 16, 1897. No. 17862 B.

The Enclosed-Arc Lamp. William H. Freedman. Illustrates and describes the mechanism, regulation, etc.; the life of the carbons, intensity and distribution of light, advantages and disadvantages. 2400 w. Am Elect'n—Jan., 1898. No. 17550.

Central Station.

See Electrical Engineering, Power.

Counter E. M. F.

Counter E. M. F. in the Electric Arc. Editorial discussion of views of various experimenters, especially criticizing the methods of research by which the conclusion that the counter E. M. F. does not exist, has been reached by two experimenters of the United States. 2400 w. Elect'n, Lond—Dec. 31, 1897. No. 17677 A.

Electric Beacon.

Testing an Enormous Electric Beacon. Describes the electric beacon known as the Lepoute "bivalve" being tested at Tompkinsville, Staten Island, N. Y. Ill. 600 w. Elec Wld—Jan. 15, 1898. No. 17722.

Glasgow.

Electric-Light Installation at the Western Infirmary, Glasgow. Illustrated detailed description. 2300 w. Elec Eng, Lond—Jan. 7, 1898. No. 17905 A.

Isolated Plant.

Power Plant of the Roman Catholic Protectory, Philadelphia. Illustrated description of the mechanical plant for lighting a large group of buildings. 1300 w. Eng Rec—Jan. 8, 1898. No. 17660.

Japan.

Some Japanese Electric Light Stations. Brief illustrated description of outfits of Japanese make, giving exterior and interior views. 600 w. Power—Jan., 1898. No. 17625.

Lamp.

See Mining and Metallurgy, Mining.

Lamp Renewal.

The Renewal of Burnt Out Incandescent Lamps. (Die Verwerthung Ausgebrannter Glühlampen.) Describes the various methods which have been proposed for restoring burnt out filaments, none of which is found to pay. The latest method of Becher, of Vienna, is the most promising, and uses a lamp with a long neck which can be cut and a new filament inserted. 1500 w. Elektrotech Zeitschr—Dec. 23, 1897. No. 17865 B.

New Orleans, La.

The New Station of the Edison Electric Co., of New Orleans, La. Illustrated detailed description. 2300 w. Elec Eng, N. Y.—Jan. 20, 1898. No. 17935.

Profit.

Electric Lighting for Profit. Alexander Dow. Paper read before the Northwestern Electrical Assn., with discussion. Gives the writer's opinions on the profits, rates, business methods and general needs of the electric-lighting business. 4800 w. Elec Wld—Jan. 29, 1898. No. 18072.

Vacuum Tubes.

Tesla's Latest Advances in Vacuum-Tube Lighting. Nikola Tesla. Experiments on the application of tubes of high illuminating power to photography and other purposes. Ill. 1000 w. Elec Rev, N. Y.—Jan. 5, 1898. No. 17558.

POWER.

Alternators.

Unipolar Self-Exciting Alternators. J. L. Routin. Translated from *L'Eclairage Electrique.* Describes an arrangement by which a generator may operate without the help of a rectifying commutator. 700 w. Elec, N. Y.—Jan. 26, 1898. No. 18027.

Burglar-Proof Safe.

An Electrically Operated Burglar-Proof Safe. Illustrated description of the construction and operation of a safe for the protection of the costly tabernacle for the sacrament in St. Augustine's Church, Brooklyn, N. Y. 600 w. Elec Wld—Jan. 15, 1898. No. 17723.

Central Station.

Combined Light and Power Plants. (Ein Beitrag zur Frage der Zusammenlegung von Licht- und Kraft-Werken.) Showing by diagrams of the relative demand at different hours, the advantage of using the same station for both kinds of service. 1000 w. Zeitschr f Elektrotechnik—Dec. 15, 1897. No. 17871 B.

The Factors which Control the Profitableness of Central Electric Stations. (Ueber die Faktoren welche die Rentabilität der Elektricitätswerke Beeinflussen.) With diagrams showing the subdivisions of cost and relative efficiency. German and English plants are compared. Two articles. 5000 w. Elektrotech Zeitschr—Dec. 23, 30, 1897. No. 17866 E.

Circuit Breakers.

Circuit Breakers and Their Use in Power Transmission. W. H. Tapley. Considers in detail the protection demanded by a large manufacturing plant using individual motors as power supply, and claims the demands have been met in the modern circuit breakers. 3300 w. Elec Eng N. Y.—Jan. 27, 1898. No. 18037.

Coal Cutter.

See Mining and Metallurgy, Coal and Coke.

Conductors.

Notes on the Cost of Conductors for the Transmission of Electrical Power with High Voltage Currents. M. P. Boucherof in *La Lumière Electrique.* A discussion of the problem of determining the cost of transmission. 800 w. Prac Eng—Dec. 31, 1897. No. 17698 A.

Cranes and Lifts.

Electric Lifts and Cranes. H W. Raven-Shaw. Read before the Institution of Civil Engineers, (England) March 30, 1897. Considers the electrical and mechanical problems in the application of electric motors to working lifts and cranes, and describes some methods by which they have been solved. Ill. 3000 w. Col Guard—Jan. 14, 1898. No. 17995 A.

See also Mechanical Engineering, Shop and Foundry.

Distribution.

A Means of Diminishing the Energy Losses in Alternating Current Transformer Distribution. From *l'Industrie Electrique.* Describes and illustrates the apparatus devised by Alfred Schlatter, which has given good results. 1800 w. Elect'n, Lond—Jan, 14, 1898. No. 18009 A.

The Elements of a Theory of Distribution. (Elemente einer Theorie der Schaltungen.) Arthur Wilke. A theoretical and mathematical discussion of the fundamental principles of electrical distribution. 5000 w. Serial. Part I. Zeitschr f Elektrotechnik—Dec. 15, 1897. No. 17870 B.

Dynamos.

Some Practical Points on the Design of a Shunt Dynamo. V. Zingler. Attempts to show

how a dynamo may be calculated from first principles so that it may be put in the shops, and so that the winding as specified by the calculations will actually go on. 1400 w. Elec Rev, Lond—Jan. 7. 1898. Serial. 1st part. No. 17906 A.

Electric Driving.

Electricity in Mining and Workshops. (Die Elektricität im Bergbau und Hüttenbetrieb.) With especial reference to the applications of continuous and polyphase currents, and illustrations of generators and motors. 4500 w. Stahl und Eisen—Jan. 1, 1898. No. 17853 D.

Electric Locomotive.

See Street and Electric Tramways.

Electrical Machinery.

The Electrical Machinery of Brown, Boveri & Co., Baden. A. E. Levin. Illustrated detailed description of works and machinery manufactured. 2500 w. Elec Wld—Jan. 8, 1898. Serial. 1st part. No. 17619.

Elevators.

See Mechanical Engineering, Miscellany.

Exposition.

Dynamos and Motors at the Leipzig Exposition. (Dynamomaschinen und Elektromotoren auf der Leipziger Ausstellung.) With general plan of the exhibiting plants and views of the leading exhibits. 2000 w. Die Elektricität—Dec. 18, 1897. No. 17861 B.

Fans.

See Mining and Metallurgy, Mining.

Generators.

Electric Generators. H. F. Parshall and H. M. Hobart. Part first considers the variety of materials entering into the construction, and the need of testing them, also the methods. Ill. 2000 w. Engng—Jan. 7, 1898. Serial. 1st part. No. 17783 A.

Grain Elevator.

The Great Northern Electric Grain Elevator at Buffalo, N. Y. O. E. Dunlap. Illustrated detailed description of one of the largest structures of its kind, 1500 w. Elec Eng, N. Y.—Jan. 27, 1898. No. 18036.

Haulage.

See Mining and Metallurgy, Mining.

Hydraulic Plant.

A Large Hydraulic Plant at Columbia, S. C. Illustrated description of a plant for generating electricity for street railway, lighting, or industrial purposes. 1400 w. Eng Rec—Jan. 1, 1898. No. 17508.

Locomotive.

See Railroad Affairs, Maintenance of Equipment.

Meters.

The Management of Central Station Meter Systems. Caryl D. Haskins. Considers that meters should always be installed in as small units as possible. Discusses their care and intelligent management and the effect upon revenue. 4500 w. Elec Wld—Jan. 1, 1898. No. 17527.

Motors.

Some Notes on Single-Phase Motors. A. C. Eborall. Classifies and discussess the motors of this type now in the English and Continental markets. Ill. 1500 w. Elec Rev, Lond—Jan. 14, 1898. Serial. 1st part. No. 18013 A.

See Street and Electric Tramways.

Niagara Power.

Niagara Power in Buffalo. Horatio A. Foster. Read before the Real Estate Exchange, Buffalo, N. Y. States briefly what has been done up to date to place the power in condition for use, discussing also how the power will be distributed, cost, &c. 2000 w. W Elect'n—Jan. 8, 1898. No. 17702.

Power Plant.

The Development of Electric Power Stations. (Die Entwicklung der Elektricitätswerke.) Giving an account of the growth of light and power stations in various parts of the Continent, especially in Berlin and Vienna. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 17, 1897. No. 17809 B.

The Rand Central Electric Power Plant. Illustrated description of plant furnishing power for mining purposes. 1100 w. Elect'n, Lond—Dec. 24, 1897. No. 17591 A.

Printing Plant.

The Electric Plant of the Government Printing Office. Illustrated detailed description of the new electric light and power plant in operation at Washington, D. C. 1700 w. Elec Wld—Jan. 15, 1898. Serial. 1st part. No. 17721.

Pumping.

See Mining and Metallurgy, Mining.

Repairs.

See Street and Electric Tramways.

Sparking.

A New Method of Avoiding Sparking in Continuous-Current Machines. J. Fischer-Hinnen. From *Elektrotechnische Zeitschrift*. Remarks on the method known as Ryan winding, and the advantage of its application to motors. Ill. 600 w. Elect'n, Lond—Jan. 14, 1898. No. 18007 A.

A New Method of Preventing Sparking in Continuous Current Generators. (Eine Neue Methode zur Vermeidung der Funkenbildung von Gleichstrommaschinen.) J. Fischer-Hinnen. An improvement on the Ryan method, similar to that of Swinburne. Small auxiliary poles are placed opposite the armature with compensating coils to neutralize the armature reaction. 1200 w. Electrotech Zeitschr—Dec. 30, 1897. No. 17867 B.

Three-Phase Plant.

The Three-Phase Plant of the Tide-Water Oil Company. Illustrates and describes a plant which has been in use two years for the purpose of transmitting power to points where an inflammable mixture of oil fumes and air was likely to occur, and which has been giving as good results as the direct current systems. 1000 w. Elec Wld—Jan. 22, 1898. No. 17926.

Tramway Power.

See Street and Electric Tramways.

Transformers.

Some Laws of Rotary Transformers. J. E. Woodbridge and Charles T. Child. Analytical discussion of certain properties dealing with questions in the practical design of such machines. Part first discusses the single-phase rotary. 2500 w. Elec Wld—Jan. 1, 1898. Serial. 1st part. No. 17518.

Trolley Wagon.

The Caffrey Trolley Road Wagon. W. G. Caffrey. Explains a system of transportation, naming the requisites the writer considers necessary for its success. Ill. 1200 w. Elec Eng, N. Y.—Jan. 20, 1898. No. 17937.

TELEGRAPHY AND TELEPHONY.

Berliner Patent.

"Independent" Telephone Companies and the Berliner Microphone Patent. Full text of a letter issued Jan. 1, 1898, by the Independent Telephone Assn. of America. 1600 w. Elec Eng, N. Y.—Jan. 27, 1898. No. 18038.

Cables.

The Capacity Ratios of Cables. (Die Kapacitätsverhältnisse in Kabeln.) Dr. H. Andriessen. A mathematical discussion of the relations of the various capacities of a cable for different condenser arrangements. The relations of several telephone wires in the same cable are discussed. 3000 w. Elekrotech Zeitschr—Dec. 30, 1897. No. 17868 B.

The Electrostatic Capacity of a Two-Wire Cable. George W. Patterson, Jr. Read at the Detroit meeting of the A. A. A. S. A mathematical study. 700 w. Phys Rev—Nov-Dec., 1897. No. 17709 D.

Coherers.

Discontinuous Electrical Conductors. (Conductibilité des Radioconducteurs ou Conducti. bilité Electrique Discontinue.) Edouard Branly. A study of a number of substances suitable for use in coherers, and a comparison between their action and that of nerve sensation. 1500 w. Comptes Rendus—Dec. 27, 1897. No. 17830 D

Fire Alarm.

The Evolution of the Fire-Alarm Telegraph. Historical Review. Ill. 1500 w. Fire & Water—Jan. 1, 1898. Serial. 1st part. No. 17548.

Induction Coil.

The Induction Coil of the Würtemberg Telephone System. (Der Fernsprechübertrager der Württembergischen Telegraphenverwaltung.) A flat coil is used with core of stamped iron, the design enabling a coil injured by lightning to be readily replaced. 500 w. Elektrotech Zeitschr—Dec. 23, 1897. No. 17864 B.

Pioneer Work.

The History of the Telephone. George C. Maynard. Review of the pioneer work with Bell's great invention. 1600 w. Elec Rev, N. Y.—Jan. 5, 1898. No. 17559.

Printing Telegraphs.

The Telescriptor and the Zerograph. (Teleskriptor und Zerograph.) Describes two new forms of "long-distance typewriters" recently brought out in Germany. The Zerograph can be operated readily with alternating or polyphase currents. 1800 w. Die Elektrizität—Dec. 4, 1897. No. 17860 B.

Submarine Cables.

Localization of Breaks and Partial Earth Faults in Submarine Cables. Gives a short description of Kennelly's alternative methods, the laws governing the same, and also the modified laws advanced by Mr. Schaefer, and discusses the relative merits of the two tests. 2500 w. Elec Rev, Lond—Dec. 31, 1897. No. 17676 A.

Ocean Cables in War Times. Alexander Porter Morse, in the *Albany Law Journal*. Gives the number and extent of ocean cables, and shows that the United States would be at a great and embarrassing disadvantage in the event of war. 800 w. W Elect'n—Jan. 8, 1898. No. 17701.

Synchronograph Tests.

Tests of the Synchronograph on the Telegraph Lines of the British Government. Albert Cushing Crehore and George Owen Squier. Abstract of a report to the Postmaster-General of the United States, read before the Franklin Inst. A description of these trials and remarks on the results especially in connection with the Wheatstone receiver. 3800 w. Elec Wld—Jan. 29, 1898. No. 18071.

Telephony.

The Future of the Telephone. F. Jarvis Patten. Reviews the development of the telegraph, and compares the history of the telephone, predicting that the next step will be the perfecting of the telephone repeater, thus making possible telephonic communication at any distance. 1700 w. Elec Wld—Jan. 1, 1898. No. 17521.

The Past Year's Advance in the Art of Telephony. Kempster B. Miller. In the United States, 250 patents for alleged improvements were granted. Reviews some of the more important. 2500 w. Elec Wld—Jan. 1, 1898. No. 17519.

Wireless Telegraphy.

Telegraphing Without Wires. Ernesto Mancini. Translated from the Italian *Nuova Antologia*. Reviews the work that has been done in this field and the degree of success attained. 2700 w. Chau—Feb., 1898. No. 18026 C.

Wireless Telegraphy. Edwin J. Houston and A. E. Kennelly. Reviews the work in this field and the results thus far attained. 2200 w. Elec Wld—Jan. 1, 1898. No. 17520.

MISCELLANY.

Battery.

Concerning Galvanic "Deposition" Batteries. (Ueber Galvanische "Fällungs" Elemente.) R. Lorenz. By "deposition" battery is meant that form in which the products of the chemical decomposition settle to the bottom, leaving the electrolyte in its full activity. One form consists of plates of zinc and of oxid of copper in a solution of common salt; the hydroxid of zinc is thrown down. 2500 w. Zeitschr f Elektrochemie—Jan. 5, 1898. No. 17875 B.

How Should Battery Cells Be Tested? Rankin Kennedy. Part first deals with preparations for the tests and methods used. 1600 w. Elec Rev, Lond—Dec. 24, 1897. Serial. 1st part. No. 17596 A.

New Models of the Lalande Oxid of Copper Battery. Illustrated description of important improvements upon the old types. 1000 w. Elec Rev, Lond—Jan. 14, 1898. No. 18014 A.

Capillarity.

Certain Electro-Capillary Phenomena. (Ueber die Kapillar Elektrischen Erscheinungen.) H. Luggin. Describes a number of interesting and novel experiments showing the modifications in capillarity produced by electric currents. 4000 w. Zeitschr f Elektrochemie—Dec. 20, 1897. No. 17873 B.

Clark Cell.

The Clark Standard Cell. Arthur Dearlove. A defence of this cell and explanation of the writer's use of it, and manner of constructing. 1100 w. Elect'n, Lond—Jan. 14, 1898. No. 18008 A.

Code.

The National Electrical Code. A copy of the code as adopted by the National Conference on Standard Electrical Rules, with report and discussions in New York and Chicago. 28000 w. Trans Am Inst of Elec Engs—Nov., 1897. No. 17528 D.

Commutators.

Repairing a "Burnt-Out" Commutator. Norman H. Crowell. Describes the location of the trouble and the treatment. 1400 w. Am Elect'n—Jan., 1898. No. 17552.

Conductors.

Shielded Conductors. W. A. Price. Discusses some of the problems brought out by Mr. Mordey's paper on "Dynamos." Ill. 1100 w. Elec Rev, Lond—Jan. 14, 1898. Serial. 1st part. No. 18015 A.

Electrical Interests.

The Relations between the Customer, Consulting Engineer and the Electrical Manufacturer. S. Dana Greene. Read before the N. Y. Elec. Soc. Gives a short sketch of this industry between 1887 and 1892, shows the necessity for a consulting engineer, giving the writer's views on various subjects of interest. 4200 w. Elec, N. Y.—Jan. 19, 1898. No. 17929.

Electrical Progress.

A Review of American Electrical Progress During the Year 1897. No startling discoveries, but steady advance in means and methods. A review of the most prominent changes. 1700 w. Elec Wld—Jan. 1, 1898. No. 17516.

Electrical Terms.

Practical Electrical Definitions. Louis Denton Bliss. Clear explanation of some of the electrical terms most frequently met with in reading electrical journals. 1300 w. Mach, N. Y. —Jan. 1898. No. 17627.

Electric Apparatus.

High Electromotive Force. John Trowbridge. Describes a large plant for the study of discharges of electricity through gases, and some of the results obtained. 1200 w. Sci Am —Jan. 15, 1898. No. 17781.

Electrolytes.

Surface Travel on Electrolytes. W. E. Fiske and W. D. Collins. Investigations of the availability of Ohm's law for electrolytes when in circuit with alternating currents of high frequency. 900 w. Am Jour of Sci—Jan., 1898. No. 17497 D.

France.

Electrical Industry in France During 1897. J. B. Oudin. Review of progress, devoted particularly to traction and lighting. 2200 w. Elec Wld—Jan. 1, 1898. No. 17517.

Galvanometer.

Construction of a Thomson Astatic Galvanometer. H. S. Webb. Illustrated description of a galvanometer which has proved very useful for laboratory work, and may be made very sensitive. 2400 w. Am Elect'n—Jan., 1898. No. 17551.

On the Best Resistance for a Sensitive Galvanometer. Frank A. Laws. A statement of the usual solution of the problem is given, and a solution under conditions other than those usually imposed. 1200 w. Phys Rev—Nov.-Dec., 1897. No. 17708 D.

Gas Battery.

Electricity Direct from Fuel. C. J. Reed. A criticism of work reported by Dr. Borchers in a paper read before the German Electro-Chemical Society, and published in *Zeitschrift für Elektrochemie*. 2800 w. Elec Wld—Jan. 22, 1898. Serial. 1st part. No. 17928.

Greater New York.

Greater New York and Its Electrical Features. Reviews the many uses of electricity already established and those in prospect, for transportation, lighting, telegraphing and telephoning. Ill. 3300 w. Elec Wld—Jan. 1, 1898. No. 17515.

Gutta Percha.

Gutta Percha. Eugene F. A. Obach. A series of lectures before the Society of Arts. History, general properties, geographical distribution, cultivation, analysis, exports, imports, prices, treatment, &c. Ill. 44000 w. Jour Soc of Arts. Serial. 4 parts. Dec. 24 & 31, 1897. Jan. 7 & 14, 1898. No. 17969 H.

Heat Battery.

Electricity from Coal. C. J. Reed. On the method of Sidney H. Short, giving figures from a patent issued Oct. 13, 1896. 1400 w. Elec Wld—Jan. 15, 1898. No. 17720.

Insulation.

The Insulation of Electrical Testing Instruments. J. Wright. Describes and illustrates several insulators applicable to different conditions. 2000 w. Elec Eng, Lond—Dec. 31, 1897. No. 17675 A.

The Testing of Insulators for High-Tension Service. J. R. Haskin. Describes the manner of testing the insulators for the Niagara-Buffalo transmission line. Ill. 1800 w. Elec Wld—Jan. 22, 1898. No. 17927.

Magnetization.

The Effects of Tension and Quality of the

Metal upon the Changes in Length Produced in Iron Wires by Magnetization. Byron B. Brackett. Reports investigations made, describing apparatus used and general method of working, giving results and conclusions. 6500 w. Phys Rev—Nov.- Dec., 1897. No. 17707 D.

The Magnetic Properties of Tempered Steel. (Propriétés Magnetiques des Aciers Trempés.) Mme. Sklodowska Curie. With carefully plotted curves of the results of a number of experiments with different steels, showing the important influence of the presence of small proportions of other ingredients. Steels containing tungsten or molybdenum developed the highest coercitive force. 1200 w. Comptes Rendus—Dec. 27, 1897. No. 17831 D.

Metering.

Multiple-rate Metering. Eustace Oxley. Illustrated description of new method, or a new system of applying the double-rate method of charging, which has met with great success. 4400 w. W Elect'n—Jan. 8, 1898. No. 17700.

Motion.

Note on the Motion of a Charged Body at a Speed Equal to or Greater Than That of Light. Oliver Heaviside. An argument to disprove the statement that 'it would seem impossible to make a charged body move at a greater speed than light.' 700 w. Elect'n, Lond—Jan. 14, 1898. No. 18005 A.

See also Mechanical Engineering, Miscellany.

Municipal Work.

The Application of Electricity to Municipal Work. F. J. Warden-Stevens. A résumé of the points at which electricity is becoming connected with municipal work, such as lighting, traction, &c. 5600 w. Arch, Lond—Jan. 7, 1898. No. 17911 A.

Electricity in Municipal Engineering. R. B. Owens. Read before the Northwestern Elec. Assn. at Milwaukee. Emphasizes the economy that can often be effected by generating at one point all the power required by a municipality. 1600 w. Elec Wld—Jan. 29, 1898. No. 18073.

Resistance.

A Simple Form of Current Resistance. (Ueber einen Einfachen Starkstrom Widerstand.) Describes a form of water resistance composed of metal plates in a cemented trough of water. 1200 w. Zeitschr f Elektrotechnik—Dec. 15, 1897. No. 17872 B.

Review.

Electrical Advance in the Past Ten Years. Elihu Thomson. Abstract from the *Forum*. Reviews the condition of the art ten years ago, and traces the advances and new applications of electrical energy. 2000 w. Elec Rev, N. Y.—Jan. 19, 1898. No. 17934.

Electrical Engineering in 1897. A sketch of the work in this field in England, reviewing its various branches. 3000 w. Engr, Lond—Jan. 7, 1898. No. 17798 A.

Rontgen Rays.

Report upon Some Preliminary Experiments with the Röntgen Rays on Plants. G. F. Atkinson. An interesting account of experiments made, showing that while plant tissues absorb the rays quite freely, there are no visible external injuries, and that they produce no easily discernible influence. 3500 w. Science—Jan. 7, 1898. No. 17585.

Storage Battery.

The "Hatch" Secondary Battery. Illustrated description of a storage battery made in Boston, Mass. 500 w. Elect'n, Lond—Jan. 14, 1898. No. 18006 A.

See Street and Electric Tramways.

Tariff.

Load Factor System of Charging for Electrical Energy. W. S. Barstow. Explains a system which claims while affording a uniform tariff, to improve the operating load factor, and gradually reduce the cost of manufacture. 2500 w. Elec Eng, N. Y.—Jan. 13, 1898. No. 17742.

Windings.

Windings of Polyphase Armatures. J. P. Stone. Illustrated description of how these windings are made, showing that it is rather unessential what type of connections are used as far as behavior and output of machines is concerned. 1200 w. Am Elect'n—Jan., 1898. No. 17549.

X Rays.

Note on the Mechanism of the Discharge of Conductors Struck by X Rays. (Sur le Mecanisme de la Déchargé des Conducteurs Frappés par les Rayons X.) G. Sagnac. Describing experimental investigations into the emission of secondary rays from a metal upon which X rays impinge. 1800 w. Comptes Rendus—Jan. 3, 1898. No. 17834 D.

MARINE ENGINEERING.

British Navy.

Additions to the Navy in 1897. Reviews the warships built and tried during the year. 1700 w. Engng—Dec. 24, 1897. No. 17608 A.

Explosives.

High Explosives and Modern War Vessels. Referring to experiments made on the old battleship Resistance, and the lessons to be learned. Specially studying the destruction wrought by the bursting of shells filled with high-explosives. 1800 w. Engr, Lond—Dec. 24, 1897. No. 17593 A.

Ferry System.

The Ferry System at Glasgow Harbor. Describes the system, dealing only with the cross-ferry steamers, and with the up-and down Clutha steamers traversing three or four miles of the harbor at a uniform fare of 1d. per passenger. Ill. 3000 w. Engng—Dec. 24, 1897. No. 17605 A.

Lifeboats.

Hydraulic Lifeboats. Sydney Walker Barnaby. Paper selected from the Transactions of Inst. of Civ. Engs., England. Describes the latest steam lifeboat which has been built by Messrs. Thornycroft and Company for the South Holland Lifeboat Institution, and which is stationed at the Hook of Holland. Ill. 1700 w. Prac Eng—Dec. 24, 1897. No. 17604 A.

Lighthouses.

The New Lighthouses on Lundy Island. The importance to mariners of this island at the entrance of Bristol Channel, is explained; the old lighthouse and the changes made in it reviewed; and the new lighthouses described. 1300 w. Engng—Jan. 7, 1898. Serial. 1st part. No. 17786 A.

Marine Engines.

The Evolution of the Marine Engine. Osborne Atwater Day. Brief review of progress in engines of ocean-going vessels. 1600 w. Yale Sci M—Dec., 1897. No. 17546 C.

Oil Fuel.

Oil Fuel Experiments on Hydraulic Life Boat "Queen." John Platt. Read before the Washington meeting of the Am. Soc. of Naval Engs. General description with particulars of trials, and drawings of the boiler. 2200 w. Ir Age—Jan. 20, 1898. No. 17940.

Seaports.

See Civil Engineering, Harbors.

Shipbuilding.

Recent Progress in the Building of Merchant and War Ships in Germany. (Neuste Erfolge des Deutschen Handels- und Kriegsschiffbaues.) With description of recent German vessels and illustrations of launches of the Kaiser Friedrich, and Victoria Luise. 4000 w. Stahl und Eisen—Dec. 15, 1897. No. 17851 D.

Rules Adopted by United States Navy Department for Riveting Naval Vessels. Instructions recently issued for the purpose of standardizing the type of rivets used for naval vessels, with general rules for spacing. Ill. 1400 w. Marine Engng—Jan., 1898. No. 17662 C.

Shipbuilding and Marine Engineering in 1897. Reviews the shipbuilding industry of Great Britain and explains the marked decrease in tonnage, &c., with additional information of interest. 4000 w. Engng—Dec. 24, 1897. Serial. 1st part. No. 17609 A.

I. Shipbuilding and Marine Engineering in 1897. II. Shipbuilding Prospects for 1898. Brief review of progress during the last year in Great Britain is given, with editorial on the prospect for the present year. 6000 w. Ind & Ir—Jan. 14, 1898. No. 17991 A.

Shipbuilding as a Productive Industry in Great Britain. James McKechnie. Treating chiefly of the increase of steam and decrease of sail tonnage during the past ten years, with especial reference to the various shipbuilding districts of Great Britain. 3500 w. Engineering Magazine—February, 1898. No. 18078 B.

Torpedo Boats.

Conditions Governing Torpedo Boat Design. R. C. Smith. Reviews the considerations controlling future design, the uses of torpedo-boats and destroyers, and related subjects. 3300 w. N Am Rev—Jan., 1898. No. 17536 D.

Torpedo Destroyer.

H. M. S. Fame, a Recent Type of British Torpedo-Boat Destroyer. Brief illustrated description. 500 w. Marine Engng—Jan., 1898. No. 17661 C.

Tramp Steamship.

First American Steel Tramp Steamship Now Building at Bath, Maine. Illustrated description of a boat designed with great care and much skill. 900 w. Marine Engng—Jan., 1898. No. 17663 C.

MECHANICAL ENGINEERING.

BOILERS, FURNACES AND FIRING.

Boilers.

A Study of Boiler Types. J. P. Johnston. Read at meeting of Civ. Engs'. Club, of Cleveland, O. Discusses types of boilers; selection of boilers; specifications; uses and abuses; and possibilities. 2500 w. Ir Trd Rev—Jan. 6, 1898. No. 17621.

Steam Generators. (Les Chaudières.) C. Walckenaer. Discussing the circulation in water-tube boilers, with many illustrations of the various constructions, together with a description of the numerous forms of instantaneous steam generators, such as are used on steam motor carriages, &c. Three articles. 25,000 w. Revue de Mécanique—Feb., Apr., May, 1897. No. 17887, each H.

Circulation.

A Contribution to the Study of the Circulation of Water in Steam Boilers. (Contribution à l'Etude de la Circulation de l'Eau dans les Chaudières.) Ch. Bellens. A review of the theory of M. Brillié, criticising the latter's application of principles of hydrostatics to problems in hydrodynamics, and offering a new theory to account for the phenomena described in his experiments. Serial. Part I. 2500 w. La Revue Technique—Jan. 10, 1898. No. 17825 D.

Coal Ash.

See Mining & Metallurgy, Coal and Coke.

Furnace.

See Mining and Metallurgy, Miscellany.

Mechanical Draft.

Influence of Mechanical Draft on Ultimate Efficiency of Steam Boilers. Extract from a work prepared by Walter B. Snow, and published by the B. F. Sturtevant Co., of Boston. Considers the influence from a commercial standpoint, as measured by its aggregate first cost, and the consequent fixed charges thereon. 2000 w. Ir Age—Jan. 27, 1898. No. 18040.

Stay-Bolts.

Concerning Stay-Bolts. A discussion of means of detecting broken stay-bolts, and the cause of the breakage. 1800 w. Locomotive—Dec., 1897. No. 17703.

Steam Raising.

Steam Raising by Water-Tube Boilers. Harold W. Kolle. Read before the Gloucestershire Engineering Society. States the requirements of a perfect steam boiler, briefly considers bent-tube and straight-tube boilers, and how far they fulfill these requirements, and the advantages of the water-tube over the shell construction. 2200 w. Col Guard—Jan. 14, 1898. No. 17996 A.

COMPRESSED AIR.

Air Motors.

The Hoadley-Knight Compressed Air Motors Describes and illustrates this type of car, giving details of construction. 2300 w. R R Gaz—Dec. 31, 1897. No. 17487.

Explosions.

Compressed Air Explosions. Frank Richards. Refers to the discussion of Mr. Dickie's paper before the A. S. M. E. and considers any reference to the fact that fatal explosions of vaporized oil have occurred with air compressors as unnecessary. 900 w. Am Mach—Dec. 30, 1897. No. 17474.

Compressed Air Explosions. William E. Gibbs. A letter to the editor giving an experience of the writer, where an explosion was in his opinion caused by the ignition of oil vapor or spray mixed with air. 1200 w. Am Mach—Jan. 13, 1898. No. 17729.

Explosions of Air Compressors. Translated and condensed from *Gluckauf*. Investigations made by the L. A. Riedinger Machine Co., of Augsburg, Germany. 900 w. Am Mach—Jan. 27, 1898. No. 18058.

Iron Cleaning.

Opinions on the Sand-Blast for Cleaning Structural Iron. Reports that the consensus of replies from about twenty prominent engineers is that the use of the sand-blast for this purpose is wise and judicious. Based on work on the 155th St. Viaduct in New York. 800 w. Eng News—Jan. 13, 1898. No. 17715.

Pneumatic Tools.

Improved Pneumatic Tools for Foundry Use. George H. Robbins. Read at meeting of Foundrymen's Assn., Philadelphia. Mentions defects in the old style of tools, faults in operating, the amount of work, &c. 1800 w. Ir Age—Jan. 13, 1898. No. 17719.

The Harthan Pneumatic Tool. Describes a chipping tool, or a combined hammer and chisel. Ill. 1000 w. Am Mach—Jan. 13, 1898. No. 17727.

Pneumatic Tubes.

The Batcheller System of Pneumatic Tubes. Illustrations showing the main features of the mail service between the main Post-Office and the Produce Exchange office of New York. 1700 w. Am Mach—Jan. 25, 1898. No. 17952.

ENGINES AND MOTORS.

Automobile Motor.

Roots and Venables Oil-Motors and Mechanism for Vehicles. An illustrated description of the latest model of this firm. It is intended for road vehicles and embodies their most recent improvements. 1600 w. Automotor Jour—Jan., 1898. No. 18065 A.

Balanced Valves.

Note on Balanced Slide Valves. (Note sur les Tiroirs Equilibrés.) M. Troisier. Devoted especially to the valves used on the locomotives of the Eastern Railway of France, and also describing other systems used in England and the United States. Gives methods of computing the proper area to be relieved of pressure. 5000 w. Revue de Mécanique—Feb., 1898. No. 17886 H.

Blowing Engines.

Valves for Blowing Engines. (Ueber Gebläseventile) H. Hörbiger. Illustrating and describing improved forms of annular air valves for blast furnace blowing engines. 3000 w. Stahl und Eisen—Jan. 1, 1898. No. 17855 D.

Compression.

Experiments on the Compression of Steam in the Clearance Space. (Expériences sur la compression de la Vapeur dans l'Espace Mort.) M. Dwelshauvers-Dery. A very important paper showing the causes for the inability of compression to prevent the losses due to excessive clearance. 8000 w. Revue de Mécanique—Oct., 1897. No. 17897 H.

Experiments on the Compression of Steam in the Clearance Space. M. Dwelshauvers-Dery. Translated from the Revue de Mécanique. A full translation of Prof. Dery's important paper. 3000 w. Power—Jan., 1898. Serial. 1st part. No. 17626.

Current Motor.

Floating Dam for the Production of Electric Energy. (Ein Schwimmendes Durchlauf-Wehr als Erzeuger Elektrischer Energie.) An illustrated account of the von der Heydt current motor system, with turbines on horizontal axes, placed in a pontoon dam. 3500 w. Der Elektro-Techniker—Dec. 15, 1897. No. 17878 B.

The Utilization of Running Streams. (Utilisation des Eaux Courantes.) The von der Heydt current motor consists of a pontoon dam containing turbines and electric generators, and which may be swung aside readily in order to afford a clear waterway. 2500 w. La Revue Technique—Dec. 25, 1897. No. 17821 D.

Deep-Well Pump.

A New Continuous Flow Deep-Well Pump. E. E. Johnson. Describes briefly the direct-acting steam deep-well pump and the air-lift pump as the two methods now in use, and gives illustrated description of a new continuous-flow deep-well pump, tests of actual plants, &c. 1500 w. Eng News—Jan. 20, 1898. No. 17942.

Engine Construction.

Steam Engine Construction and its Relation to Electrotechnics. (Der Dampfmaschinenbau und Seine Beziehungen zur Elektrotechnik.) A

paper by Prof. Gutermuth, of Dresden, discussing the special influence which the development of electric stations has had upon the construction and design of steam engines. 6000 w. Zeitschr d Ver Deutscher Ing—Dec. 11, 1897. No. 17801 D.

Engine Tests.

Determination of the Fundamental Data of a Steam Engine Test. (Detérmination des Données Fondamentales dans un Essai de Machine à Vapeur.) M. Dwelshauvers-Dery. Giving instructions as to the application of Hirn's analysis to a steam engine test, including all the necessary data for the computation of the heat exchanges. An important contribution to the science of steam engineering. Three articles, 22000 w. Revue de Mécanique—Jan., Mar., May, 1897. No. 17881, each H.

Gas Engines.

Gas and Petroleum Motors. (Les Moteurs à Gaz et à Pétrole.) G. Richard. A very fully illustrated series of descriptive articles covering the entire field of internal combustion motors as at present constructed in Europe and America. Three articles. 15000 w. Revue de Mécanique—Jan., Mar., May, 1897. No. 17885, each H.

On the Utilization of Blast Furnace Gases by Means of the Gas Engine. William Galbraith. Results of the working at Wishaw, Scotland. 2700 w. Prac Eng—Jan. 7, 1898. No. 17908 A.

The Economy and Efficiency of the Large Gas Engine. Dugald Clerk. Discussing the leading problems now awaiting solution before larger engines can be commercially successful; also, reference to improvements desired in producers for power gas. 2500 w. Engineering Magazine—February, 1898. No. 18077 B.

The Gas Engine and Its Mission. Sidney A. Reeve. Part first gives a brief historical review and discusses the general arrangement and methods of governing and of ignition, types of valves and color of paint. 4000 w. R R Gaz—Jan. 7, 1898. Serial. 1st part. No. 17561.

Hydraulic Engine.

An Hydraulic Engine. Arthur Rigg. Reviews various makes of hydraulic engines, and notes the wasteful manner in which the pressure water is applied, when operating under partial loads, and gives illustrated description of invention of the writer. 3000 w. Engr, Lond—Jan. 14, 1898. No. 17989 A.

Hydraulic Plant.

See Electrical Engineering, Power.

Mill Engine.

1600 Indicated Horse-Power Triple-Expansion Mill Engine. Illustrated description of engine made by Messrs. Cole, Marchent and Morley (England). 1500 w. Engr, Lond—Jan. 14, 1898. No. 17990 A.

Rotary Engine.

Hult's Rotary Engine. Illustrated detailed description of an engine awarded a gold medal at the recent Stockholm Exhibition. 1200 w. Engng—Dec. 24, 1897. No. 17606 A.

Steam Engine.

A Patent Steam Engine. I. A. Ferrari. An explanation, from a theoretical point of view, on the efficiency of a patent steam-engine, as an improved means for producing a rotary from a reciprocating motion. Ill. 1100 w. Prac Eng—Jan. 7, 1898. No. 17907 A.

The Condensation of Steam in Steam Engines and its Measurement. A summary of the investigations reported in paper of H. L. Callendar and J. T. Nicolson, read before the British Assn. with comments. 3500 w. Engr, Lond—Dec. 31, 1897. Serial. 1st part. No. 17693 A.

The Steam Engine in the United States. (La Machine à Vapeur aux Etats-Unis.) R. H. Thurston. A general account of modern steam engine practice in the United States, followed by a description of the construction of the experimental engines at Cornell University, and accounts of tests made upon them. Four articles. 16000 w. Revue de Mécanique—May, July, Sept., Nov., 1897. No. 17892, each H.

Superheated Steam.

Engines for Superheated Steam. (Ueber Heissdampfmaschinen.) A. Seemann. With a full account of the remarkable performances of the Schmidt superheated steam engine, which used only 9.8 lbs. of steam per h. p. hour. Three articles. 12000 w. Zeitschr d Ver Deutscher Ing—Dec. 11, 18, 25, 1897. No. 17800 H.

The Application of Superheating to Steam Engines. (Application de la Surchauffe aux Machines à Vapeur.) F. Sinigaglia. A fundamental investigation of superheating from a theoretical and practical point of view, with many descriptions of apparatus and reports of tests. Six articles. 20,000 w. Revue de Mécanique—Mar., Apr., June, Aug., Oct., Dec., 1897. No. 17891, each H.

Turbines.

Low Pressure Turbines with Increased Rotative Speed. (Ueber Niederdruckturbinen mit Gesteigerter Umdrehungszahl.) Prof. R. Escher. A mathematical discussion showing that by modifying the bucket curves a higher rotative speed can be obtained than usual with low heads, thus enabling direct connection to be made with electric generators. 1800 w. Schweizerische Bauzeitung—Jan. 8, 1898. No. 17840 B.

POWER AND TRANSMISSION.

Aerial Railway.

Aërial Railway in Colombia. Translated copy of the contract for the construction of an aërial railway between the city of Honda and Argualarga or its suburbs. 1600 w. Cons Repts—Jan., 1898. No. 17735 D.

Belts.

Selection, Handling and Care of Belts. Charles H. Garlick. Some advice on this subject, giving serviceable rules for obtaining width, length, &c., and discussing the value of rubber and leather belts, and matters relating to the adjustment. 1800 w. Min & Sci Pr—Jan. 22, 1898. No. 18054.

Hoisting.

Hoisting Machinery. (Les Appareils de Levage.) Including jacks, chain blocks, link belt

elevators, conveyors, &c. Three articles. 12000 w. Revue de Mécanique—Feb., Apr., Aug., 1897. No. 17890, each H.

Pulleys.

The American All Wrought-Steel Pulley. Illustrated detailed description of how it is manufactured. 2500 w. Ir Age—Jan. 6, 1898. No. 17576.

Transmission.

See Mining and Metallurgy, Mining.

SHOP AND FOUNDRY.

Annealing.

The Annealing of Cast Iron. George C. Davis. Read at meeting of Foundrymen's Assn., Philadelphia. Reviews the opinions of various writers and gives conclusions from the writer's experience. 1600 w. Ir Age—Jan. 13, 1898. No. 17718.

Casting.

Casting a Fly-Wheel. R. Brief description of the plant of the Sessions Foundry Co., of Bristol, Conn., with account of the casting of a big fly-wheel. Ill. 2300 w. Am Mach—Jan. 13, 1898. No. 17725.

Clean Iron Castings. Walter J. May. General discussion of the subject, noting the difficulties, faults, &c., and means of overcoming them. Gives test results where one of the new forms of ferro-sodium is used, showing how this flux affects iron. Considers a good flux a desirable thing. 1700 w. Col Guard—Jan. 7, 1898. No. 17790 A.

Crane.

Electrically Driven Cranes. (Elektrisch Betriebene Krane.) C. Eberle. The first of a series upon electric cranes built in Germany. This article contains description of a single-motor travelling crane by Collet and Engelhard, and a travelling jib crane by Scholten. Serial. Part I. 4500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 1, 1898. No. 17805 D.

Dividers.

Divider Points for Vernier Calipers. Describes an attachment designed by the writer, which will not interfere with other uses of the caliper, and will give the added advantages of an accurately graduated scale and fine screw or vernier adjustment. Ill. 2300 w. Am Mach—Dec. 30, 1897. No. 17475.

Electric Driving.

See Electrical Engineering, Power.

Electrical Machinery.

See Electrical Engineering, Power.

Etchings.

Shop Etchings. J. A. Carney. Read before the St. Louis Ry. Club. Short accounts of the methods of manufacture of iron and steel are given, the process of etching described and its use. Ill. 1800 w. Ir Age—Jan. 20, 1898. No. 17941.

Gates.

Molders' Gates. R. D. Moore. Hints concerning the shaping of gates. Ill. 700 w. Am Mach—Jan. 13, 1898. No. 17728.

Gearing.

The Generation of Gear-Tooth Outlines. (Das Erzeugung der Zahnformen für Räder.) Hermann Fischer. A general review of the various mechanical methods of generating the shapes of teeth for spur and bevel gearing directly in the gear-cutting machines. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 1, 1898. No. 17806 D.

Hydraulic System.

See Mining and Metallurgy, Mining.

Lathes.

Lathe and Shaper Work. A. H. Cleaves. Illustrated description of methods of doing work. 1500 w. Am Mach—Dec. 30, 1897. No. 17476.

Slotting in the Lathe, John Randol. Describes a rather unusual piece of shop work. 1000 w. Am Mach—Jan. 20, 1898. No. 17953.

Lifts and Cranes.

See Electrical Engineering, Power.

Lubrication.

A Study of Lubrication. (Etude sur le Graissage.) E. Maglin. Discussing the chemical and physical laws of lubrication, with illustrated descriptions of a variety of devices for testing lubricants. Two articles. 8000 w. Revue de Mécanique—July, Oct., 1897. No. 17895, each H.

Metalloids.

The Value of Metalloids in Cast Iron. Malcolm McDowell. Read at meeting of the Western Foundrymen's Assn., Chicago. Showing the advantage of buying and selling pig iron by analysis. Also discussion. 4000 w. Ir Age—Jan. 27, 1898. No. 18041.

Milling.

Milling Spirals in the Lathe.—Tools for Grooving Cams in the Drill Press. A. H. Cleaves. Illustrated description of practices of value. 1500 w. Am Mach—Jan. 27, 1898. No. 18057.

Molding.

Molding Columns in the Floor. L. C. Jewett. Gives a sketch of a column and the rigging used to mold it, with description of process. 700 w. Am Mach—Jan. 6, 1898. No. 17567.

Ordnance.

The Construction of Modern Wire-Wound Ordnance. Part first describes the preparation of the wire used. 3000 w. Engr, Lond—Jan. 7, 1898. Serial. 1st part. No. 17797 A.

Pulleys.

See Mechanical Engineering, Power and Transmission.

Pumps.

Pumping Machinery. (Les Pompes.) M. Masse. A comprehensive essay, beginning with the hydraulic ram, and including hand and steam pumps, both vertical and horizontal, with a mathematical analysis of the discharge from a number of connected pumps. Five articles. 28000 w. Revue de Mécanique—Feb., Mar.,

June, Sept., Nov.,1897. No. 17888, each H.

Pumps—Inside Connected and Inside Packed, Walter Ferris. Favoring outside packed pumps. Ill. 1600 w. Am Mach—Jan. 6, 1898. No. 17566.

Pumping Engine.

See Mining and Metallurgy, Mining.

Riveted Joints.

Experiments on the Frictional Resistance of Riveted Joints. Schröder van der Kolk. A paper before the Royal Institution of Engineers of Holland, translated from the *Zeitschrift des Vereines deutscher Ingenieure.* Gives conclusions from careful experiments made to determine the degree of influence exerted by frictional resistance on the strength and general efficiency, with particular reference to railway-bridge design. 800 w. Prac Eng—Jan. 14, 1898. No. 18069 A.

Screw Dies.

The Hartness System of Screw Dies. An illustrated description of die head, including a brief account of the method of making the chasers. 1700 w. Am Mach—Jan. 6, 1898. No. 17568.

Shop Suggestions.

Shop Talks with the Young Mechanics. W. H. Van Dervoort. The first of a series of talks aiming to present some points relating to tools and their correct and efficient use. Part first deals with the hammer and cold chisel. Ill. 1800 w. Mach, N. Y.—Jan., 1898. Serial. 1st part. No. 17629.

Shop Work.

An Example of Shop Work. A. L. G. Illustrated description of how a number of special interchangeable spindles were made. 1200 w. Mach, N. Y.—Jan., 1898. No. 17628.

Tools.

Machine Tools. (Les Machines-Outils.) G. Richard. Elaborately illustrated articles upon improvements in machine tools since 1895; especially devoted to American lathes and milling machinery. Four articles. 28000 w. Revue de Mécanique—Feb., Apr., June, Oct., 1897. No. 17889, each H.

Turbines.

Machines of the Turbine Class (Les Turbo-Machines.) A. Rateau. A series of articles on the various machines of the turbine class, including hydraulic and steam turbines, fans, centrifugal pumps, and screw propellers. The two articles thus far published are devoted to the mathematical principles involved. Two articles. 12000 w. Revue de Mécanique—July, Sept., 1897. No. 17894, each H.

Worm Gearing.

Modern Practice with Worm Gearing. F. A. Halsey. A presentation of the general conditions of successful practice as in use at present. Prof. Barr's theory of worm efficiency is examined and the most efficient thread angles are given, based largely upon the experiments of Wilfred Lewis. 2000 w. Am Mach—Jan. 13, 1898. No. 17726.

MISCELLANY.

Animal Power.

Comparison of the Thermal or Dynamical Power of Simple Elements with their Nutritive Power. (Comparaison du Pouvoir Thermogène ou Dynamogène des Eléments Simples avec leur Pouvoir Nutritif.) A. Chauveau. An investigation into the possible cause of the high efficiency of animal power based on the food consumed. A valuable investigation of the nature of animal power. 4500 w. Comptes Rendus—Dec. 20, 1897. No. 17828 D.

Artillery.

Artillery Construction. (Le Matériel d'Artillerie.) Colonel X. Discussing and illustrating the latest improvements in breech-closing devices, both wedge and screw; also rapid fire guns and carriages for field pieces with improved cushioning devices. Five articles. 30,000 w. Revue de Mècanique—June, July, Sept., Oct., Dec., 1897. No. 17893, each H.

Automobiles.

Post-Office Motor Vans. An account of the trials made in England with self-propelled vehicles for carrying mails. 500 w. Engr, Lond—Dec. 24, 1897. No. 17595 A.

Report on Motor Vehicles in France. (Bericht über die Motorwagen in Frankreich.) A translation of the report on the recent "heavy-weight" competitions of automobiles in France. Serial. Part 1. 7500 w. Glaser's Annalen—Jan. 1, 1898. No. 17814 D.

Automobile Motor.

See Mechanical Engineering, Motors.

Bicycles.

Conclusions Deduced from Efficiency Tests of Bicycles. R. C. Carpenter. Explains the meaning of "efficiency" as here used, gives various tests which show little loss of power in the ball bearings, great loss in the tire, and considerable in the gearing. 2400 w. Sib Jour of Engng—Jan., 1898. No. 18016 C.

Bicycle Tires.

Progress in the Weaving of Bicycle-Tire Fabrics. From *The Cycle Age* (Chicago). Reviews the history of pneumatic tires, the difficulties encountered and the extent to which they have been overcome. 2000 w. Ind Rub Wld—Jan. 10, 1898. No. 17966 D

Creusot Works.

See Mining and Metallurgy, Iron and Steel.

Elevators.

Hydraulic or Electric Elevators. William H.. Bryan. Extracts from a report submitted to owners of a St. Louis building, stating the advantages of each. 1600 w. Eng Rec—Jan. 1, 1898. No. 17507.

Entropy.

The Entropy Diagram and its Applications. (Le Diagramme Entropique et ses Applications.) Prof. J. Boulvin. A very lucid and thorough treatise on the principles of thermodynamics, with practical applications of the entropy diagram to steam and gas engines as well as refrigerating machinery. Four articles. 26000 w.

Revue de Mécanique—Jan., Feb., Apr., June, 1897. No. 17882, each H.

Flat Surfaces.

The Theory of Flat Heads. (La Théorie des Fonds Plats.) C. Walckenaer. A very full discussion of the experiments of Prof. Bach of Stuttgart upon the strength of flat heads of cylindrical vessels subjected to internal pressure. 12000 w. Revue de Mécanique—Dec., 1897. No. 17899 H.

Gutta Percha.

See Electrical Engineering. Miscellany.

Levels.

A Level of Ye Olden Time. Otto von Geldern. Historical review of the earliest contrivances for this use, and a memoir published with the papers of the Royal Acad. of Paris for the year 1704, by M. de la Hire, describing a level on the principle of fastening an iron rule at its center of gravity to an upright support canting on its base. Discussion. 7500 w. Jour Assn of Engng Soc—Dec., 1897. No. 17976 C.

Mechanics.

Mechanical Engineering. Editorial review from the English standpoint, dealing with motor cars, railroading, refrigerating machinery, &c. 7000 w. Engr, Lond—Jan. 7, 1898. No. 17901 A.

Moisture.

Determining the Moisture in Steam Pipes. D. S. Jacobus. Abstract from a paper in *The Stevens Indicator*. Describes a method which has given reliable data, pointing out the advantages over other methods. 1300 w. Eng News—Jan. 27, 1898. No. 18030.

Motion.

Note on the Propagation of Motion. (Sur la Vitesse de Propagation d'un Mouvement.) P. Vieille. An investigation of the velocity of propagation of a movement in a medium which is at rest showing experimentally that the velocity is that of sound in the same medium. 1500 w. Comptes Rendus—Jan. 3, 1898. No. 17833 D.

See also Electrical Engineering, Miscellany.

Range Finder.

The Weldon Range Finder, Its Use and Its Theory. Alston Hamilton and H. L. Hawthorne. On the value of this range finder, and the uses to which it may be applied. 4000 w. Jour U. S. Artillery—Nov-Dec., 1897. No. 17738 D.

Refrigeration.

Refrigerating Machinery. (Les Machines Frigorifiques.) G. Richard. Describing the various machines introduced since 1889, with accounts of their applications, records of tests, and determination of data for subsequent use in designing refrigerating apparatus and investigating the theory of these machines. Four articles, with many illustrations. 20000 w. Revue de Mécanique—Jan., Mar., May, Sept., 1897. No. 17884, each H.

Roller Bearings.

Mr. W. Hugh Woodcock on Roller Bearings. Excerpt from a paper read before the Liverpool Section of the Self-Propelled Traffic Assn. Discusses the requirements of a satisfactory roller bearing, and reports tests. 4000 w. Automotor Jour—Jan., 1898. No. 18066 A.

See also Railroad Affairs, Maintenance of Equipment.

Screw Threads.

Rules for the Construction of Machine Screw Threads. (Régles pour la Construction des Vis Mécaniques.) E. Sauvage. Discussing the new metric screw thread system adopted by the *Société d'Encouragement pour l'Industrie Nationale*, and also the standard wire gauge of the same society. With graphical scale of screw proportions and a comparison with English and American threads. 4000 w. Revue de Mécanique—May 1897. No. 17770 H.

Stack.

The Raising of a 150-Stack in One Piece. Describes the raising of a stack at Haysville, near Pittsburg, at the works of the Sterling Varnish Co. Ill. 1200 w. Am Mfr & Ir Wld—Jan. 21, 1898. No. 17983.

Strength Recorder.

A Spring Ergograph. (Sur un Ergographe à Ressort.) MM. Binet and Vaschide. An improved apparatus for recording physical efforts, so arranged as to register the maximum strength of the subject. 1000 w. Comptes Rendus—Dec. 27, 1897. No. 17829 D.

Testing.

Determination of the Elasticity of the Same Specimen under Tension and Compression. (Ermittlung der Zug-und Druckelastizität an dem gleichen Versuchskörper) C. Bach. The improved indicators for showing the variations in length of a test specimen enable accurate measurements to be made both under tensile and compressive stresses. Photographs of the apparatus in use are given, together with data of a series of tests on cast iron. 4000 w. Zeitschr d Ver Deutscher Ing—Jan. 8, 1898. No. 17808 D.

Testing Machine.

A Photographic Impact Testing Machine for Measuring the Varying Intensity of an Impulsive Force. B. W. Dunn. Discussion of this paper. 4300 w. Jour Fr Inst—Jan., 1898. No. 17649 D.

Traction.

Mechanical Traction. (La Traction Mécanique.) A. Barbet. The introductory article of a series, treating in a general way of the use of common roads for motor vehicles and to be followed by a discussion of the various improvements in mechanical traction. 5000 w. Revue de Mécanique—Nov., 1897. No. 17898 H.

Wire Nails.

The Shearing Strength of Wire Nails. A thesis by Frank Bates Walker and Charles H. Cross, University of Minnesota. Statement of experiments made by the writers with tabulated results. Also discussion. Ill. 3800 w. Jour Assn of Engng Socs—Dec., 1897. No. 17977 C.

MINING AND METALLURGY.

COAL AND COKE.

Belgium.

Coal Mining in the Liège District of Belgium. From a Foreign Office report by Vice-Consul Menzies. 1200 w. Col Guard—Dec. 24, 1897. No. 17603 A.

Coal and Iron.

The Foreign Coal and Iron Trades in 1897. Review of these industries in Germany, France, Sweden, Belgium, Russia and Austria. 6500 w. Ir & Coal Trds Rev—Dec. 31, 1897. No. 17668 A.

Coal Ash.

Relation between the Composition of Coal Ash and its Fusibility. (Relation entre la Composition des Cendres de Houille et leur Fusibilité.) A notice of the investigations of M. Eugène Prost, showing that the fusibility of an ash depends upon the relation between the lime, magnesia and oxid of iron on one part, and the silica and alumina on the other. 1500 w. Moniteur Industriel—Dec. 11, 1897. No. 17836 G.

Coal Bed.

The Pittsburg Coal Bed. I. C. White. A consideration of the age, structure, area, importance and value. 4000 w. Am Geol—Jan., 1898. No. 17667 D.

Coal-Cutter.

The Schaub Electrical Coal-Cutter. V. Waltl, *Oesterreichische Zeitschrift für Berg-und Huttenwesen.* Illustrated description of a machine presenting many interesting points, being tried at the Piberstein Brown-Coal Colliery in Austria. 1800 w. Col Guard—Jan. 7, 1898. No. 17791 A.

Coal Storage.

Coal Storage Plant of the Tamarack Mining Co., Dollar Bay, Mich. Illustrated description of the principal structural features of this plant. 1000 w. Eng News—Dec. 30, 1897. No. 17478.

Coal Trade.

The Coal Trade in 1897. Reviews the English trade of the year in Northumberland, Durham, Lancashire, Yorkshire, &c., also the business in Scotland and London. 8500 w. Col Guard—Jan. 7, 1898. No. 17788 A.

Coke.

Concerning Sulphur in Coke. (Ueber den Schwefelgehalt des Koks.) Giving analyses of cokes from various parts of Europe, and discussing the effect of the presence of sulphur upon the iron smelted with such fuel. 2500 w. Stahl und Eisen—Jan. 1, 1898. No. 17854 D.

Coke Oven.

The Collin Coke Oven. Notes the particular features and describes how the ovens are used. Ill. 1600 w. Col Guard—Jan. 7, 1898. No. 17789 A.

Explosions.

Explosions in Coal Mines. John Hayes. Part first considers the gases exuded in coal-mines and those causing explosions, giving examples, with review of experiments recorded. 3000 w. N Zeal Mines Rec—Dec. 16, 1897. Serial. 1st part. No. 17917 B.

Explosives.

New Order as to the Use of Explosives in Coal Mines. A new order, dated Dec. 20, 1897, repealing all previous orders, and based on list of explosives which have passed the official test at the Royal Arsenal, Woolwich, Eng. 4000 w. Col Guard—Dec. 24, 1897. No. 17602 A.

The Testing of Explosives for Use in Coal Mines. Report of the English Departmental Committee appointed to inquire into the best tests to determine the safety. 3400 w. Col Guard—Dec. 24, 1897. No. 17600 A.

Formation.

The Formation of Coal. H. F. Bulman. From *Journal of the British Society of Mining Students.* Brief consideration of theories advanced. 1200 w. Col Guard—Jan. 14, 1898. No. 17994 A.

Mine Plant.

Coal Mine Plant at Diamondville, Wyo. W. P. Hardesty. Brief description of a substantial plant recently built. 700 w. Eng News—Dec. 30, 1897. No. 17479.

Ohio Coal.

The Geology of the Jackson Shaft Coal. Andrew Roy. Read at meeting of Ohio Inst. of Mining Engs. Describes this peculiar deposit in Southern Ohio. 1800 w. Am Mfr & Ir Wld —Jan. 21, 1898. No. 17984.

Peat.

Coking Peat. Dr. Holtz, in *Zeitschrift für Angewandte Chemie.* Describes the Ziegler-Stiemer process of preparing the pressed peat; coking; and utilizing the products. 800 w. Col Guard—Jan. 7, 1898. No. 17796 A.

Portugal.

Buarco's Colliery, Cabo Mondego, Portugal. From a communication by M. Sylva Cattier to the Charleroi Committee of the Society of Hainaut Engineers. Information of the structure of the seam, quality of the coal, method of working, &c. 1200 w. Col Guard—Dec. 31, 1897. No. 17689 A.

GOLD AND SILVER.

Auriferous Beaches.

Auriferous Beaches on the West Coast. Mr. Macfarlane. These beaches contain gold in immense quantities, intimately associated with magnetite and other minerals. Gives conclusions reached as to the source of the gold, and to the probability of good returns from the working of these beaches. 2000 w. N Z Mines Rec—Nov. 16, 1897. No. 17583 B.

Australia.

Notes on Western Australia Mines. Jos. Gruss. Information of mining affairs from one recently returned from this region. 2700 w. Min & Sci Pr—Jan. 1, 1898. No. 17617.

British Columbia.

Boundary and Trail Creek Mining Districts of British Columbia. W. L. Austin. Describes the country, the geological formations, occurrence of the ores, their character and value, and the extent of their development. 6000 w. Mines & Min—Jan., 1898. No. 17758 C.

British Columbia Mines in 1897. William A. Carlyle. Reports the condition of the mining industry, and gives brief description of the principal mining districts. 1800 w. Eng & Min Jour—Jan. 8, 1898. No. 17630.

California.

California Mines in 1897. Reviews the improvements in connection with the mining industry, and the work generally. 1200 w. Eng & Min Jour—Jan. 8, 1898. No. 17633.

Colorado.

Colorado Past and Present. Reviews the condition forty, thirty, twenty and ten years ago, and gives the output of precious metals and review of the mining industry during the past year. 8500 w. Min Ind & Rev—Jan. 6, 1898. No. 17664.

Mining in Gilpin County, Colorado, in 1897. George E. Collins. Reviews the different districts showing a large increase over 1896. 2500 w. Eng & Min Jour—Jan. 15, 1898. No. 17773.

Mining in Lake County, Colorado, in 1897. A summary of the year's work and the operations of importance being conducted. 3600 w. Eng & Min Jour—Jan. 22, 1898. No. 17972.

Cripple Creek.

Cripple Creek, Colorado, Mines in 1897. Reviews the work of the past year, showing the outlook to be very favorable. 1200 w. Eng & Min Jour—Jan. 8, 1898. No. 17632.

Cyanid.

Influence of the Anodes in Depositing Gold from its Cyanid Solution. E. Andreoli. Refers to the important work in this field and the results, and gives the writer's experience with peroxidized lead anodes. 1500 w. Eng & Min Jour—Jan. 22, 1898. No. 17971.

Cyanogen.

The Solvent Powers of Cyanogen. William Skey. Condensed paper describing tests made and giving some facts ascertained. 900 w. Min & Sci Pr—Jan. 15, 1898. No. 17950.

Gold-Bearing Stones.

The Witwatersrand Banket, With Notes on Other Gold-Bearing Pudding Stones. George F. Becker. Part first is introductory, giving an outline of the geological position and the relations to the auriferous regions of Southern Africa. 800 w. Min & Sci Pr—Jan. 15, 1898. Serial. 1st part. No. 17951.

Goldfields.

The Geology and Veins of the Hauraki Goldfields. James Park. Read before the New Zealand Inst. of Mining Engs. Abstract of paper on one of the most interesting gold-bearing areas of New Zealand. 2800 w. N. Z. Mines Rec—Nov. 16, 1897. No. 17582 B.

Gold Mine.

A Great Gold Mine. John W. Gray. The story of Mount Morgan, Australia, is briefly told. 1800 w. Min & Sci Pr—Jan. 15, 1898. No. 17949.

Klondike.

The Klondike Gold Fields. Gives views of two prominent men who have spent some time in this region, and also comments on the preparations being made in Victoria for the coming trade. 1500 w. Cons Repts—Jan., 1898. No. 17496 D.

Milling.

Notes on Milling Gold-Bearing Ores. The importance of a knowledge of metallurgy for the profitable milling of gold, the occurrence, processes, &c. 2800 w. Min Ind & Rev—Jan. 13, 1898. No. 17932.

Montana.

Montana Mines in 1897. Shows that the adoption of the single gold standand has been one cause of the renewed activity in placer mining and gives a brief summary of the principal mines. 1600 w. Eng & Min Jour—Jan. 8, 1898. No. 17636.

New South Wales.

The Wolumla Goldfield. J. E. Carne. Report on the geology and auriferous resources of this gold field in the southern district of New South Wales. 2800 w. Aust Min Stand—Dec. 16, 1897. Serial. 1st part. No. 17923 B.

Peru.

Gold Mines of Peru. Report on the gold district of Carabaya, Peru, by the late civil engineer, E. J. Prew. 1700 w. Cons Repts—Jan., 1898. No. 17737 D.

Prospecting.

Magnetic Methods of Prospecting in Sweden. From a report on the mining industry in Sweden, 1897, by Prof. Nordenström, of the Stockholm School of Mines. The instruments described have been utilized in all the mining districts and yielded valuable results, not only for iron, but also zinc, copper, nickel, and cobalt when mingled with magnetic minerals. 2400 w. Col Guard—Dec. 24, 1897. No. 17601 A.

Reef Disturbance.

Reef Disturbance in Westralia. Paper recently read by Mr. Horsley, before the Mine Managers Inst. of W. A. Discusses the causes and effects of the disturbance of reefs from the decomposition of rocks. 1600 w. Aust Min Stand—Dec. 9, 1897. No. 17920 B.

Separation.

The Separation of Gold and Silver in the Mint. Howard Lee Davis. Describes the nitric-acid, and the sulphuric-acid methods. 2300 w. Yale Sci M—Dec., 1897. No. 17544 C.

Testing.

Laboratory Testing of Ores for Concentration and Amalgamation. H. Van F. Furman. Information relating to how laboratory tests should be made, and the importance of making them before a mill-run is made. 2000 w. Min Ind & Rev—Jan. 13, 1898. No. 17933.

Victoria.

A Victorian Auriferous Zone. Ernest Lidgey. Gives facts relating to the reefs of the western portion of Victoria, with detailed information. 2400 w. Aust Min Stand—Dec. 16, 1897. No. 17922 B.

Washington.

The Deu Pree Lode, Washington. Henry Landes. Some account of mining development in the Cascade Mountains, with description of the property named. 2000 w. Eng & Min Jour—Jan. 8, 1898. No. 17631.

Witwatersrand.

The Gold Mines of the Witwatersrand, South Africa. John Hays Hammond. The first of an important series of papers upon the development of the gold mines of the Transvaal. This paper deals with the rapid development of the region and with its geological features, including the several theories as to the origin of the formations. 4000 w. Engineering Magazine—February, 1898. No. 18075 B.

Yukon.

Geology of the Yukon. Condensed from advanced sheets of work by Josiah Edward Spurr. Describes the rocks and the disturbances they have undergone, in part first. Min & Sci Pr—Jan. 22, 1898. No. 18055.

IRON AND STEEL.

Creusot Works.

Messrs. Schneider and Co.'s Works, Creusôt. Historical and descriptive. Ill. 2000 w. Engng—Jan. 7, 1898. Serial. 1st pa No. 17784 A.

Granulated Slag.

Brick Manufacture from Granulated Blast Furnace Slag. Condensed translation of article by F. W. Luermann, in *Stahl und Eisen*. Information relating to the manufacture and testing of these bricks. 900 w. Am Mfr & Ir Wld—Jan. 14, 1898. No. 17761.

Iron Industry.

The Iron Industry of the United Kingdom. Leonard H. Courtney. The second part of a presidential address on "Jevons' Coal Question: Thirty Years After," delivered before the Royal Statistical Society. 2300 w. Col Guard—Dec. 24, 1897. No. 17599 A.

Iron Mines.

The Iron Mines of Minnesota in 1897. Reports a larger production than ever before with information regarding labor, transportation, &c. 1500 w. Eng & Min Jour—Jan. 8, 18,8. No. 17635.

Iron Ore.

The Outcrop of the Oolitic Iron Ore in the Southern Part of German Lorraine. (Das Vorkommen des Oolithischen Eisenerzes in Südlichen Theile Deutsch-Lothringens.) Fr. Greven. A geological description, with large colored map and sections of the locality. 6000 w. 2 plates. Stahl und Eisen—Jan. 1, 1898. No. 17852 D.

Steel Analysis.

Bibliography of the Metallography of Iron and Steel. Albert Ladd Colby. Prepared as an aid to those who wish to study the microscopic examination of these metals. 6000 w. Ir Age—Jan. 27, 1898. No. 18039.

Steel Making.

The Tropenas Steel-Making Process. The object of this invention is to obtain by pneumatic means, greater heat than is reached by the ordinary pneumatic process, and to secure a material of greater ductility. Illustrated description of the system is given, with report of tests. 2300 w. Engng—Jan. 14, 1898. No. 17998 A.

MINING.

Damages.

Delay in Seeking Remedy for Mining Damages. An explanation of English mining law on this subject. 3000 w. Col Guard—Dec. 24, 1897. No. 17598 A.

Economic Operation.

The Relation of the Mining Engineer to the Economic Operation of Coal Mines. S. A. Taylor. Read before the Central Mining Inst. of Western Pennsylvania, at Pittsburg. Showing how well it pays to employ an engineer to conduct the mining operations. 2000 w. Am Mfr & Ir Wld—Jan. 7, 1898. No. 17652.

Electric Driving.

See Electrical Engineering, Power.

Explosives.

Explosives for Use in Fiery Pits. J. von Lauer, in *Oesterreichische Zeitschrift für Berg- und Hüttenwesen*. Part first gives methods by means of which explosives may be employed with safety and economy. 1200 w. Col Guard—Jan. 14, 1898. Serial. 1st part. No. 17997 A.

Measures Adopted for Diminishing the Danger of Shot-Firing. Abstract from an official report by Bergassessor Dröge, Saarbrucken, published in the *Zeitschrift für das Berg-, Hütten, und Salinenwesen*. Gives particulars relating to the condition of the collieries, and the regulations in force as regards shot-firing. 3800 w. Col Guard—Jan. 14, 1898. Serial. 1st part. No. 17992 A.

The Use of Explosives in Gaseous Mines. (Sprengmittel mit Rücksicht auf ihre Verwendung in Schlagwetter führenden Gruben.) Joh. v. Lauer. A valuable paper discussing the action of blasting explosives in igniting firedamp, and giving the conditions under which they may be safely used. Two articles, 12,000 w. Oesterr Zeitschr f Berg-u Hüttenwesen—Dec. 18, 25, 1897. No. 17856 E.

Underground Magazines for Mine Explosives. From a report of the French Firedamp Commission by M. Ledoux. Regulations in different countries are given, with a summary of conclusions adopted in France, and discussion of the subject in general. 3500 w. Col Guard—Dec. 31, 1897. No. 17687 A.

Fans.

Experiments Upon Propeller Ventilating Fans, and Upon the Electric Motor Driving Them. William George Walker. Read before the

Institution of Mech. Engs., England. Part first notes former experiments, describes apparatus used, measurement of air discharge and of brake horse-power, &c. Ill. 3000 w. Prac Eng—Jan. 7, 1898. Serial. 1st part. No. 17909 A.

Notes on Mine Fans. William T. Clifford. Read at meeting of Western Pennsylvania Central Mining Inst., at Pittsburg. Traces the advances made in mine fans with consideration of some features. 1800 w. Am Mfr & Ir Wld—Jan. 7, 1898. No. 17653.

Firedamp.

Investigations as to the Ignition of Firedamp and Coal Dust by Electricity. (Versuche betreffend die Entzündlichkeit von Schlagwettergemischen und Kohlenstaubaufwirbelungen durch die Wirkungen der Elektrizität.) An account of the important experiments made at Gelsenkirchen by Herr Heise and Dr. Thiem. Serial. Part I. 4500 w. Glückauf—Jan. 1, 1898. No. 17850 B.

Haulage.

Electric Haulage for Mines. D. C. Thomas. Extract from a paper read at meeting of the Ohio Mining Inst. Points of importance are discussed and details given that will tend to bring satisfactory results. 1300 w. Ir Trd Rev—Jan. 27, 1898. No. 18056.

Hydraulic System.

The Brown Hydraulic System for Underground Pumping and Haulage. William F. Lang. Read before the Mining Inst. of Scotland. A description of the adaptation of this system to mining purposes. 1800 w. Col Guard—Dec. 31, 1897. No. 17686 A.

Lamp.

Accumulator-Maintained Miner's Lamp. M. G. Nicolai to the Liège section of the Assn. des Ingénieurs de Liège. Extract. Description and report of trials. 1300 w. Col Guard—Jan. 7, 1898. No. 17794 A.

Mexican Mine.

The Avino Mines. Auguste Mathez. An illustrated description of an old Mexican mine and the good and bad points of some of the ancient methods still in use. 2300 w. Mines & Min—Jan., 1898. No. 17753 C.

Mine Fire.

The Aspen Mine Fire. Arthur Lakes. The geology of Aspen and the conditions existing in the Smuggler mine at the time of the fire, some of the difficulties and the methods employed in extinguishing the fire, with report of the superintendent. Ill. 4000 w. Mines & Min—Jan., 1898. No. 17756 C.

Mining Law.

Covenants to Work Mines. Reviews decisions under English law upon this subject. 2800 w. Col Guard—Jan. 7, 1898. No. 17792 A.

Damages for Breaches of Contract in the Coal Trade. British law on this subject is shown by report of important cases. 2800 w. Col Guard—Dec. 31, 1897. No. 17685 A.

The Criminal Law Relating to Mines. An exposition of British law on this subject. 2400 w. Col Guard—Jan. 14, 1898. No. 17993 A.

Mining Stock.

The London Mining Stock Market in 1897. A brief description of the features of interest. 2000 w. Eng & Min Jour—Jan. 8, 1898. No. 17637.

Pumping.

Electric Mine Pumping. F. C. Whitmore. Read before the Engineers' Club of Scranton, Pa. A comparison of the relative efficiencies of steam and electric pumps, with some reasons why electric pumps admit of greater economy than steam pumps. 2000 w. Mines & Min—Jan., 1898. No. 17755 C.

Pumping Engine.

A Duplex Hydraulic Pumping Engine. Stuart McMurtrie. From the *Journal of the British Society of Mining Students*. Describes the principle and working of a Hathorne Davey pumping-engine installed at Radstock. Ill. 1200 w. Col Guard—Jan. 7, 1898. No. 17793 A.

Respirator.

Respirators for Mining Work. (Ueber Athmungsapparate beim Bergbaubetriebe.) Johann Mayer. A general review of the various respirators for enabling exploration and relief to be done in gaseous or burning mines. The Neupert respirator, with oxygen reservoir and carbonic acid absorbent is illustrated. Serial. Part I. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Jan. 1, 1898, No. 17858 B.

Speaking Tubes.

Long-Distance Speaking Tubes in Mines. Schale, in *Zeitschrift für Berg-, Hütten-, und Salinen-Wesen*. Conclusions from results of experiments made to obtain material for guidance in setting up long-distance tubes and ascertaining the limits attainable for communication. 1000 w. Col Guard—Dec. 31, 1897. No. 17688 A.

Sweden.

Swedish Mining Work in 1897. (Schwedens Bergbaue im Jahre 1897.) A general review of the work of the past year, including iron, copper and zinc, as well as the other metals which occur in minor quantities. 2500 w. Oesterr Zeitschr f Berg-u Hüttenwesen—Dec. 18, 1897. No. 17857 B.

Transmission.

Transmission of Power by Ropes in Mines. G. D. Rice. Illustrated description of the main jack-wheel and connections designed for an installation operating five rope-drives from a tower. 800 w. Eng & Min Jour—Jan. 22, 1898. No. 17970.

Underground Work.

The Underground Work of the Samuelsglück Mine at Beuthen. (Unterwerksbau der Samuelsglück-Grube bei Beuthen.) An account of the extension of the underground work of a lead and zinc mine in Upper Silesia. Steam is conducted 2500 feet underground, to operate pumping and hoisting machinery. 1500 w. Zeitschr d ver Deutscher Ing—Jan. 1, 1898. No. 17807 D.

Ventilation.

Adequate Ventilation. E. W. Thirkell. Read before the Midland Inst. of Mining, Civil and Mechanical Engs. at Barnsley, March 27, 1897, and published in the Fed. Inst. of Mining Engs. The amount of air needed for men, horses and lights under various conditions, the effects of gases, methods of improving the ventilation and dangers from coal-dust. 3000 w. Mines & Min—Jan., 1898. No. 17754 C.

Hanarte's Contribution to the Study of Mine Ventilation. J. W. P. The substance of a preface called forth by the new edition of M. Haton de la Goupilliere's *Course of Mine Working*. 1500 w. Col Guard—Jan. 7, 1898. No. 17795 A.

MISCELLANY.

Aluminum.

The Impurities of Aluminum and its Alloys. (Sur les Impuretés de l'Aluminium et de ses Alliages.) P. Defacqz. A paper presented to the French Academy by M. Moissan; the principal impurities found were iron and silica; the methods of analysis are given. 1500 w. Comptes Rendus—Dec. 27, 1897. No. 17832 D.

Furnace.

Open Hearth Glass Furnaces. (Fours à Bassins pour Verriers à Vitre.) The Gobbe furnace, as used at the Jumel glass works in Belgium, gives much better results than pot melting. Producer gas is used and the homogeneous glass drawn from beneath the surface of the molten charge. A modification of the furnace is used for firing porcelain, &c. 3500 w. 1 plate. La Revue Technique—Jan. 10, 1898. No. 17827 D.

Kryolith.

Kryolith—Its Mining, Preparation and Utilization. William C. Henderson. An interesting account of this isolated deposit in Greenland, the methods of mining, process of producing soda, and other uses. 2500 w. Jour Fr Inst—Jan., 1898. No. 17650 D.

Metalloids.

See Mechanical Engineering, Shop & Foundry.

Metal Markets.

The London Metal Markets in 1897. Reviews the markets of copper, tin, spelter and antimony. 3500 w. Eng & Min Jour—Jan. 15, 1898. No. 17772.

Mica.

Mica-Mining in Bengal. Describes the region, the occurrence and methods of mining. 1500 w. Ind & East Engr—Dec., 1897. No. 17948 D.

Missouri.

The Ore Market of the Joplin, Missouri, District in 1897. Reports the condition of the zinc and lead industry. 1200 w. Eng & Min Jour—Jan. 8, 1898. No. 17634.

Peru.

A Rich Peruvian Mining Region. William Griffith. A geological description of the mineral resources in the neighborhood of Hualgayoc, Peru, with some account of the methods of mining, and the quaint village. 1700 w. Mines & Min—Jan., 1898 No. 17757 C.

Precious Stones.

Geography of Precious Stones. George F. Kunz. An interesting lecture considering the subject in several aspects. The famous gem regions, their influence on discovery and exploration, the building up of cities through this industry, commerce, &c. 4500 w. Jour Fr Inst—Jan., 1898. Serial. 1st part. No. 17648 D.

Review.

The Technical Literature of the Year. H. G. Graves. Review of the year's literature of the coal and iron industries, aiming to show the general trend thought has taken. 3000 w. Col Guard—Dec. 31, 1897. No. 17684 A.

School of Mines.

School of Mines for the Witwatersrand. John Daniell. Refers to some of the best-known schools of mines, and the systems of instruction adopted, making suggestions relating to this special field. 2800 w. Chem & Met Soc of S. Africa—Nov. 20, 1897. No. 17543 D.

Statistics.

The Mineral Statistics for 1897. The usual annual report published by this paper, containing full and valuable information of all the minerals and metals in the United States, and the production of gold in the whole world. 42000 w. Eng & Min Jour—Jan. 1, 1898. No. 17540.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Accounts.

Both Sides of the Ledger. Norton N. Humphrys. A consideration of the profits earned in the gas industry, and the means of ascertaining them. 2000 w. Jour Gas Lgt—Jan. 4, and 11, 1898. Serial. 2 parts. No. 17799 E.

Acetylene.

Acetylene from the Underwriters' Standpoint. E. B. Shuttleworth. Report submitted as the result of study of the manufacture and use of acetylene. Considers manufacture, storage and carriage of calcium carbid; manufacture of acetylene at low pressure; use of low pressure acetylene for illuminating purposes; use of compresses or liquefied acetylene for illuminating purposes. 5000 w. Can Eng—Jan., 1898. No. 17760.

Explosion of an Acetylene-Gas Plant in the Post Office Building, Wilmington, Del. W. A. Jones. Describes the plant and gives facts gathered, and inferences as to its cause. Ill. 1700 w. Eng Rec—Jan. 15, 1898. No. 17766.

Regulations for Acetylene Lighting at Berlin. Translated from the "*Zeitschrift für Beleuchtungswesen*. Regulations relative to the pro-

duction and use, for employers, and workmen in other than large works. 1500 w. Pro Age—Jan. 1, 1898. No. 17502.

The Technical Analysis of Calcium Carbid and Acetylene and the Purifying of the Latter. G. Lunge and Edward Cedercreutz. Gives method proposed by the authors to determine, analytically, the possible 4% of impurities in acetylene. 1800 w. Gas Wld—Jan. 1, 1898. No. 17674 A.

Composimeter.

Principle of the Gas Composimeter. Edward A. Uehling. Illustrated description of apparatus, and explanation of principle. 1800 w. Gas Wld—Jan. 15, 1898. No. 18004 A.

Distribution.

Facts versus Logic in the Distribution of Gas. J. P. Gill. Criticism of a contribution by D. Coats Niven to the *Journal of Gas Lighting*, in reference to "the Distribution of Gas." 1200 w. Am Gas Lgt Jour—Jan. 24, 1898. No. 17982.

Gas Sales.

Gas Sales in the United States, Canada, England and Germany. Extract from the presidential address of Charles H. Nettleton, at the meeting of the American Gas Lgt. Assn 1000 w. Eng News—Jan. 20, 1898. No. 17945.

Gas Works.

An Examination of the Construction of the City Gas Works at Simmering (Besichtigung des Baues des Städtischen Gaswerkes in Simmering.) Showing photographic views of retort house, gas holders, &c, in course of construction for this important suburb of Vienna. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 24, 1897. No. 17811 B.

Heat Units.

The Balance Sheet of Heat Units in Coal Distillation. Herman Poole. An outline of what may be ascertained regarding the heat energy of coal and its products in gas-making. 3400 w. Am Gas Lgt Jour—Jan. 24, 1898. No. 17981.

Photometry.

The New Flicker Photometry. F. L. Tufts. Presented as a graduation thesis to the faculty of Columbia University. Outlines the general method of comparing luminosities, giving history of work of various investigators. Also describes apparatus used in the study of flicker phenomena. 3400 w. Pro Age—Jan. 15, 1898. Serial. 1st part. No. 17732.

The Weber Photometer and the Measurement of Daylight. Describes an apparatus for measuring the intensity of light given off by illuminated surfaces, also to measure the intensity of the light source. Ill. 1000 w. Gas Wld—Jan. 8, 1898. No. 17925 A.

Poisoning.

Gas Poisoning. W. B. M'Vey and J. E. Grinfield-Coxwell. Read before the Medico-Legal Society. Claims that the substitution of water-gas for coal-gas has greatly increased the danger of gas poisoning. Gives case with reports on condition at various intervals. Discussion. 2500 w. Pro Age—Jan 1, 1898. No. 17501.

Retrospect.

A Retrospect of the Year 1897. Deals principally with the gas industry in England. 4500 w. Jour of Gas Lgt—Dec. 28, 1897. No. 17615 A.

Review.

Review for the Year 1897. A lengthy review of the events of the gas industry in the United States during the year. 1600 w. Pro Age—Jan. 15, 1898. No. 17731.

Revivification.

The Heat of Revivification. Herman Poole. Discussion of the chemical action going on in the purifying material and its subsequent revivification. 2000 w. Am Gas Lgt Jour—Jan. 3, 1898. No. 17553.

Standard.

Report on the Dibdin Standard of Light. First report of a committee appointed by the Institution of Gas Engineers (England) to examine and report concerning the accuracy of the Dibdin 10-candle pentane standard. Also Mr. Dibdin's opinion. 3000 w. Gas Wld—Jan. 15, 1898. No. 18003 A.

Welsbach.

Indirect or Diffused Illumination of Class Rooms and Workshops by Welsbach Incandescent Lamps. F. Kermander and W. Prausnitz, in the *Journal des Usines a Gaz*. Translated by Herman Poole. Presents the advantages of indirect illumination, and gives results of experiments made. 900 w. Am Gas Lgt Jour—Jan. 17, 1898. No. 17774.

The Indirect Lighting of Schools by Welsbachs. F. Kermaner and W. Prausnitz. Abstract. States the fault of direct systems, the merits of indirect lighting, with practical results. 2400 w. Gas Wld—Jan. 1, 1898. No. 17673 A.

SEWERAGE.

Germany.

The Sewerage of Hanau, Germany. James H. Fuertes. Illustrated details of design and construction. 800 w. Eng Rec—Jan. 8, 1898. Serial. 1st part. No. 17657.

Purification Plant.

Rapid Double Filtration and Aeration of Sewage at Reading, Pa. Illustrated description of purification plant where the sewage is first screened through coke, then filtered twice, being aerated by dropping from the first filter bed to the second. 5500 w. Eng News—Jan. 27, 1898. No. 18028.

Sanitation.

The Sanitation of Domestic Buildings. Frank Latham. Part first is introductory and shows the danger of neglecting defective house drains, citing cases of serious illness and death from this cause. 1500 w. San Rec—Jan. 7, 1898. Serial. 1st part. No. 17769 A.

Septic Tank.

The Septic Tank System of Sewage Treat-

ment at Exeter, England. Albert S. Crane. Brief description of the plant and the method of operating. Also information from English engineering papers. 2400 w. Eng News—Jan. 13, 1898. No. 17712

Sewage.

Ammoniacal Nitrogen in Sewage and Effluents. W. J. Dibdin. A discussion of the analytical results of certain bacterial methods of treatment. Gives results of analyses obtained by the process known as the septic tank, and the Sutton system. 1200 w. San Rec—Jan. 7, 1898. No. 17768 A.

Sewer Pipe.

The Strength of Sewer Pipe and the Actual Earth Pressure in Trenches. Frank A. Barbour. Experiments are described which were undertaken to determine where and under what circumstances it is necessary to use other than standard pipe, and whether failures are due to poor pipe or poor construction. Tabulated results are given, also discussion. Ill. 17500 w. Jour Assn of Engng Socs—Dec., 1897. No. 17975 C.

STREETS AND PAVEMENTS.

Frozen Concrete.

Frozen Concrete Pavement Foundations. A pavement foundation in Des Moines, Ia., was frozen just after it was laid. Twelve months after a sample was examined and its condition is reported, with the reasons of city engineer L. Higgins for believing that the conditions may be such as not to destroy the value by freezing. 1000 w. Eng Rec—Jan. 1, 1898. No. 17506.

Street Cleaning.

Street Cleaning in New York. Describes some of Col. Waring's methods of keeping the city clean. 3500 w. Eng Rec—Jan. 8, 1898. No. 17655.

Wood Blocks.

Wood Block Pavements in Atlanta. Describes the process invented by H. F. Willams, of San Francisco, that is to be used here, and also gives report on the way in which similar pavements in San Francisco are wearing. 1300 w. Eng Rec—Jan. 1, 1898. No. 17505.

WATER SUPPLY.

Cincinnati.

Water System of Cincinnati. Information from the 57th annual report of the water department. Ill. 1300 w. Fire & Water—Jan. 8, 1898. Serial. 1st part. No. 17638.

Cleaning a Reservoir at Cincinnati. Willis P. Thorp. Describes the cleaning process used in removing the sediment from the west basin of the Eden reservoir, giving some information of former methods used. Ill. 1400 w. Fire & Water—Jan. 15, 1898. No. 17759.

Filtration.

Sand Filtration at Mount Vernon, N. Y. John S. Chester. Remarks concerning the construction and operation of this filter. Ill. 1200 w. Fire & Water—Jan. 1, 1898. No. 17547.

Fire Protection.

Supplementary Water Mains for Fire Protection. Extracts from report of Foster Crowell. Describes the systems in use in Cleveland, Milwaukee, Detroit, Buffalo, and Boston. 3800 w. Eng Rec—Jan. 8, 1898. No. 17656.

Forestry.

The Relation of Forestation to Water-Supply. Herbert M. Wilson. An important paper by the geographer of the U. S. Geological Survey, showing that there is no proof that deforestation has any appreciable effect on rainfall, or upon the subsequent run-off. 4500 w. Engineering Magazine—February, 1898. No. 18081 B.

Geological Survey.

Investigations of Water Supply by the U. S. Geological Survey. F. H. Newell. Read at meeting of the American Public Health Assn. An explanation of the extensive work done, and an application of the data to the drainage basin of the Potomac. 2200 w. San—Jan., 1898. No. 17666 D.

Metropolitan System.

Opening of the Metropolitan System, New York. The new pipe line of this system was opened on New Year's Day. In an address given the scope of the work undertaken is set forth. 1700 w. Fire & Water—Jan. 8, 1898. No. 17639.

Peoria, Ill.

Supplemental Pumping Plant of the Peoria Water Co., Peoria, Ill. Dabney H. Maury, Jr. Describes the method adopted to secure an additional water supply. The system consists of Pelton wheel driving centrifugal pumps. The construction of the plant was attended with great difficulties. Ill. 2700 w. Eng News—Jan. 13, 1898. No. 17713.

Pipe Laying.

Laying Pipe Under Difficulties. Illustrated description of a difficult piece of work in Waterbury, Conn, caused by a break in the connection of iron and cement pipes where a brook crosses the street. 1000 w. Fire & Water—Jan. 8, 1898. No. 17640.

Records.

The Best Method of Handling Applications and Permits of Water Companies. Describes and explains the use of the card index system for this purpose. 900 w. Munic Engng—Jan., 1898. No. 17532 C.

Review.

Water and Sanitary Affairs of 1897. Reviews the principal events of the year in England, relating to this subject. 3800 w. Jour of Gas Lgt—Dec. 28, 1897. No. 17616 A.

River Pollution.

The Pollution of the Potomac River. Statements from two papers read before the National Geographic Society, at Washington, one by A. A. Davis, describing the physical characteristics, drainage area, sources of pollution, etc., and the other by E. K. Sprague, dealing with the bacterial side of the subject. 1000 w. Eng News—Dec. 30, 1897. No. 17483.

Submerged Mains.

Laying Submerged Water Mains. Describes

the laying of a 16-inch pipe across the Cedar River, Iowa, and a 24-inch main at Nashua, N. H. 1000 w. Eng Rec—Jan. 1, 1898. No. 17504.

Laying a Submerged Water Main in Cleveland, O. Illustrates the manner in which a 48-inch main was laid across a narrow stream. 350 w. Eng Rec—Jan. 29, 1898. No. 18149.

Surface Waters.

On Odors and Tastes of Surface Waters, with Special Reference to Anabaena, a Microscopical Organism found in Certain Water Supplies of Massachusetts. D. D. Jackson, and J. W. Ellms. Investigations of organisms giving surface water a disagreeable odor or taste, with results of analysis, &c. 3500 w. Tech Quar—Dec., 1897. No. 17647 F.

Water Mains.

Testing Water Mains in Place at Detroit. Describes and illustrates a device for testing the pipe in short intermediate sections, irrespective of the position of the valves. 900 w. Eng Rec—Jan. 22, 1898. No. 17964.

Water Rates.

The San Diego Water-Rates Case. The text of an important decision by the Supreme Court of California. Part first give the opinion of Justice Van Fleet, Justices Henshaw and McFarland concurring. 3600 w. Eng Rec—Jan. 15, 1898. Serial. 1st part. No. 17764.

Water Storage.

Water Storage Tanks Under Air Pressure at Babylon and Southampton, N. Y. Brief description of this system of water storage. Ill. 1100 w. Eng News—Dec. 30, 1897. No. 17480.

Water Supply.

Water Supply. Editorial review of the lessons of the year, and the supply in various parts of England. 1700 w. Engr, Lond—Jan. 7, 1898. No. 17904 A.

Zurich.

The Water Supply of Zurich. (Die Wasserversorgung von Zurich.) Official report for the year 1896, giving data concerning the use of high pressure water for power, as well as city supply. Also describes bacterological and chemical researches. Capacity is 6,500,000 gallons per day. 2500 w. Gesundheits-Ingenieur—Dec. 31, 1897. No. 17846 B.

MISCELLANY.

Destructors.

Dust Destructors. George Watson. Read at meeting of Gloucestershire Eng. Soc. and reported in the *Gloucester Journal*. Abstract. Deals with the dust destructor from the earliest to tho latest developments, especially describing the Horsfall destructor furnace. Discussion. 6000 w. Elec Eng, Lond—Dec. 24, 1897. No. 17589 A.

The Bullerdeich Destructor Plant for the City of Hamburg. (Die Städtische Verbrennungsanstalt für Abfallstoffe am Bullerdeich zu Hamburg.) Describes the Horsfall and Whiley garbage destructor cells as used at Hamburg. The plant has a capacity of nearly 80,000 tons per year, and the destruction costs 0.84 mark per ton. 2500 w. Gesundheits-Ingenieur—Dec. 31, 1897. No. 17845 B.

Farm Buildings.

Sanitary Farm Buildings. Louis Hanks. The importance of farm sanitation, and suggestions of how to secure the essentials. 1600 w. San Rec—Jan. 14, 1898. No. 18012 A.

Fire Alarm.

See Electrical Engineering, Telegraphy and Telephony.

Fire Protection.

The Equipment and Organization of a City Fire Department. Hugh Bonner. A discussion of the organization of the fire department of New York City as typical of the general principles of municipal equipment, by the chief of the New York Fire Department. 4000 w. Engineering Magazine—February, 1898. No. 18080 B.

London Fire.

See Architecture and Building, Miscellany.

Municipalization.

The Juridic Side of the Municipalization of Tramways. George Beynon Harris. Part first deals with the means by which a corporation may become possessed of a tramways undertaking, according to English law. 1600 w. Elec Eng, Lond—Jan. 14, 1898. Serial. 1st part. No. 18010 A.

Municipal Work.

See Electrical Engineering, Miscellany.

New York.

New York's Civic Assets. William Howe Tolman. A summing up of the progress made during Mayor Strong's administration, giving explanation of the mistakes and praise for the patriotism and civic pride, which studied always the city's welfare, showing that the assets will far exceed the liabilities. 5000 w. Am Rev of Revs—Jan., 1898. No. 17570 C.

Public Works.

An Outline of Municipal Laws Governing Public Works. An outline by David Molitor, of what in his judgment, would be the best form of municipal government for conducting public works. 6000 w. Munic Engng—Jan., 1898. No. 17531 C.

Municipal Ownership and Municipal Control. Charles Carroll Brown. Brief discussion of what works are best owned by the city. 900 w. Munic Engng—Jan., 1898. No. 17530 C.

Refuse.

Is Dustbin Refuse a Fuel? Norton H. Humphreys. An examination of the fuel used in the Shoreditch district, and why it can be used for steam-raising purposes. Does not consider ordinary household refuse inflammable. 1700 w. Jour Gas Lgt—Jan. 25, 1898. No. 17704 A.

Sanitation.

Sanitary Engineering. Editorial review of the year's work in this field. 1500 w. Engr, Lond—Jan. 7, 1898. No. 17903 A.

RAILWAY AFFAIRS.

NEW CONSTRUCTION.

China.

Railway Building in China. J. T. M. A summary of the lines which may possibly be built in the empire in the near future. 2000 w. Ry Age—Dec. 31, 1897. No. 17539.

MAINTENANCE OF EQUIPMENT.

Axle Bearing.

The Busse Adjustable Axle Bearing for Locomotives. (Nachstellbares Achslager für Lokomotiven, Bauart Busse.) A three part axle box with improved wedge adjustment, especially intended for the journal bearings of main locomotive axles. 1200 w. Glaser's Annalen—Jan. 1, 1898. No. 17813 D.

Brakes.

Standardized Driver Brakes C. & N. W. Ry. Describes the new design made with adjustable links adopted on the Chicago & Northwestern Railway. Ill. 800 w. Am Eng & R R Jour—Jan., 1898. No. 17512 C.

Car Heating.

Combined High and Low Pressure Steam Heating System of the Prussian State Railways. (Vereinigte Hoch-und Niederdruck-Dampfheizung der Preussischen Staatsbahnen.) A system especially adapted for the compartment carriages used in Germany, and enabling the temperature to be regulated independently in each compartment. 1000 w. 1 plate. Glaser's Annalen—Dec. 15, 1897. No. 17812 D.

Economies.

Fads, Customs and Their Cost. R. P. C. Sanderson. A paper and discussion on the points where savings can be made in the maintenance of equipment, without impairing the efficiency. 20500 w. N Y R R Club—Dec. 16, 1897. No. 17762 D.

Electric Locomotive.

See Street and Electric Tramways.

Fish-Commission Car.

The Transportation by Rail of Fish and Fish Eggs. Illustrated description of the United States Fish Commission car, which is adapted for the distribution of live fishes. 1000 w. Sci Am—Jan. 8, 1898. No. 17556.

Gondola Car.

Gondola Car; Chicago & Eastern Illinois R. R. Illustrated description of a car of 80,000 pounds capacity. 900 w. R R Car Jour—Jan., 1898. No. 17670.

Intercepting Valves.

The Schenectady Locomotive Works.—Intercepting and Separate Exhaust Valves for Compound Locomotives. Sectional views with description of valve designed by A. J. Pitkin and J. E. Sague. The form illustrated is the standard construction for their compound locomotives. 1200 w. Loc Engng—Jan., 1898. No. 17588 C.

Locomotives.

A "Balanced" Locomotive? Novoye Vremya. Letter to the editor criticizing an American locomotive, and claiming the design to be inferior in almost every particular to other engines. Gives analysis of forces and expresses general disapproval. Ill. 2800 w. Engng—Dec. 31, 1897. No. 17692 A.

A Curious Tunnel Locomotive. Illustrated description of a locomotive designed to work in tunnel headings, having the limited dimensions of 8 ft. 6 in. in width and 7 ft. 6 in. in height above the level of the rails; also to work in the open. 2500 w. Engr, Lond—Dec. 31, 1897. No. 17695 A.

An English Four-Cylinder Compound Locomotive with a Two-Compartment Smoke Box. An engine of the four-cylinder compound type, designed by F. W. Webb, is illustrated and described. 700 w. Eng News—Jan. 6, 1898. No. 17574.

Building a Locomotive. An illustrated account of the building of this machine, mentioning the different branches of the work. 2000 w. Loc Engng—Jan., 1898. No. 17586 C.

Compound Locomotives. (Les Locomotives Compound.) E. Sauvage. A classified historical discussion of compound locomotives in Europe and America, with details of proportions and account of tests. Four articles, many illustrations. 30000 w. Revue de Mécanique—Jan., Mar., May, Aug., 1897. No. 17883, each H.

Cooke Locomotives for the Oregon Short-Line Railway. Illustrated description of improved consolidation locomotives recently built. 500 w. Ry & Engng Rev—Jan. 22, 1898. No. 18021.

Electric Locomotives at Potsdam. Illustrated description of a locomotive which has for two years been operated in the railway repair shops near Berlin, Germany. 400 w. Ry Wld—Jan., 1898. No. 17913 A.

Electric Locomotive on the Hoboken Shore Road. Describes and illustrates the new locomotive recently put into service for hauling trains of loaded and empty freight cars between the docks and the Erie track. 600 w. Elec Rev, N. Y.—Jan. 5, 1898. No. 17557.

Glasgow & South-Western Four-Cylinder Simple Engine. Engraving, half-sectional plan, principal dimensions, and other particulars. 400 w. R R Gaz—Jan. 14, 1898. No. 17747.

Heavy Twelve-Wheel Locomotives for the Great Northern. Illustrated detailed description with general dimensions. 1200 w. R R Gaz—Jan. 7, 1897. No. 17562.

Locomotives for the Chinese Imperial Railways. Illustrated description of the machines supplied by the Baldwin Locomotive Works of Philadelphia. 1000 w. Engng—Jan. 7, 1898. No. 17785 A.

Locomotives with Double Smoke Stack; Toledo, Peoria & Western Ry. Illustration of this device, with a statement of the advantages claimed. 400 w. Eng News—Jan. 27, 1898. No. 18032.

Locomotives with Double Valves and Ports. London & Southwestern Ry. Illustrated description with dimensions and drawings. 500 w. Eng News—Jan. 13, 1898. No. 17714.

New Locomotive Types of 1897. Illustrated description of new types introduced during the year on English railways. 2500 w. Ry Wld—Jan., 1898. No. 17914 A.

Powerful Simple Locomotives for the Great Northern Railway, U. S. A. Illustrations and a description of the interesting details of the design. This article is confined to the boiler and the cylinders. General dimensions are given. Built by the Brooks Locomotive Works. 1200 w. Am Eng & R R Jour—Jan., 1898. No. 17511 C.

The New Heilmann Electric Locomotive. L. Bayly, in *Ingenieur Electrique*, Paris. Detailed description of the latest type of this machine, with illustrations. 1300 w. Elec Eng, N. Y. —Jan. 20, 1898. No. 17936.

The Performance and Design of Locomotives. A. von Borries. Extracts from an important work, "Die Eisenbahn Technik der Gegenwart," selected and translated by W. W. Nichols. Part first is a study of the resistance to motion, and the performance of locomotives. 2000 w. R R Gaz—Jan. 14, 1898. Serial. 1st part. No. 17746.

Two Recent Baldwin Locomotives. Engravings, dimensions and other particulars. 300 w. R R Gaz—Dec. 31, 1897. No. 17486.

Repairs.

How to Make Heavy Repairs on the Locomotive Boiler. Henry J. Raps. Directions and suggestions for quick and efficient work. Ill. 3000 w. Loc Engng—Jan., 1898. No. 17587 C.

Roller Bearings.

The Theory of Rolling Surfaces. (Théorie du Roulement des Surfaces.) R. Dubois. A geometrical study of the action of rolling surfaces with especial regard to the construction of roller bearings and ball bearings for railway axles. 8000 w. Revue de Mécanique—Sept., 1897. No. 17896 H.

See also Mechanical Engineering, Miscellany.

Royal Train.

The Hungarian Royal Train. (Der Ungarische Hofzug.) An illustrated description, with interior views of the various cars, of the private train for the use of the royal family on the Hungarian railways. 1500 w. 1 plate. Zeitschr d ver Deutscher Ing—Dec. 18, 1897. No. 17802 D.

Safety Appliance.

Extension of Safety Appliance Law. On the order for extending for two years the time within which the U. S. railroads must comply with this law, with digest of arguments. 1500 w. R R Car Jour—Jan., 1898. No. 17669.

Steel Cars.

Steel Freight Cars—M. C. B. Designs. Editorial discussion of the three designs for steel cars presented at the 1897 convention, also replying to questions asked by the committee in their circular of inquiry. 1700 w. Am Eng & R R Jour—Jan., 1898. No. 17514 C.

Vestibule.

A Home Made Vestibule—Great Northern Railway, U. S. A. Drawings and description of the standard design finally adopted. 800 w. Ry Mas Mach—Jan., 1898. No. 17618.

Wheel Tests.

Tests of Special Quality Chilled-Iron Car-Wheels at Buffalo, N. Y. Reports tests, under the auspices of the Central Railway Club made to demonstrate the comparative value of steel-tired wheels, and special quality chilled-iron wheels for high-grade serivce. 1300 w. Eng News—Jan. 27, 1898. No. 18034.

Wheels.

The Mileage of Chilled Cast-Iron Wheels in Freight and Passenger Service. Tables up to date, showing service. 500 w. Am Eng & R R Jour—Jan., 1898. No. 17513 C.

MAINTENANCE OF WAY.

Outside Rail.

Forces Acting on the Outside Rail. F. T. Hatch. A study of this subject with results. Ill. 1200 w. R R Gaz—Dec. 31, 1897. No. 17485.

Railway Bridges.

Notes on Light Railway Bridges. Illustrated description of a bridge built under rather difficult conditions,—the Gerüstpheiler Viaduct, designed and carried out by the government engineers of the Saxon States Railways. It is built of trestle piers or lattice-work columns, on a curve of 125 m. radius and with a gradient of 1 : 40. Calculations of strains and details of construction are given. 4000 w. Engr, Lond—Dec. 24, 1897. No. 17594 A.

Track Elevation.

Track Elevation in Chicago. Summary of what has already been published on this subject, with additional information of interest, taken from report made to the Department of Public Works, Chicago. 1700 w. R R Gaz—Jan 14, 1898. No. 17748.

Track Inspection.

Track Inspection on the Louisville and Nashville. Describes a car recently fitted for track inspection, and the method of work. 1500 w. Ry & Engng Rev—Jan. 8, 1898. No. 17671.

SIGNALING.

Automatic Signals.

Disadvantages Attending the Operation of Automatic Signals on the Normally Danger System. J. P. Coleman. Shows some causes of relay failures, and how much more seriously the failures affect the normally danger system than they do the normally clear system. 2700 w. Ry & Engng Rev—Jan. 8, 1898. No. 17672.

Interlocking.

Interlocking Plant at State Line Crossing Near Chicago, Ill. Illustrates and describes one of the largest interlocking plants in the United States. 1700 w. Eng News—Jan. 20, 1898. No. 17946.

Signal Engineer.

The Signal Engineer. W. H. Elliott. Read

before the Railway Signaling Club. Discussion of this department of railway operation; the proper one to receive reports, and give orders, repairs, maintenance of inter-locking plant, etc., are considered. 1800 w. Ry & Engng Rev—Jan. 15, 1898. No. 17930.

Signal Work.

Foundations for Signal Work. Charles Hansel. Description with illustrations of approved design. 1100 w. R R Gaz—Jan. 7, 1898. No. 17564.

TERMINALS AND YARDS.

New York Station.

Refacing the Grand Central Station Walls. Brief description, with illustration, of the veneer of artificial stone being built over the reconstructed station, which is to give the effect of solid coursed ashlar fronts of gray stone. 800 w. Eng Rec—Jan. 15, 1898. No. 17765.

Station Enlargement.

The Enlargement of the Grand Central Station, New York, N. Y. Illustrated description of improvements being made, estimated to cost about $1,000,000. 2000 w. Eng News—Jan. 6, 1898. No. 17575.

Switzerland.

Plans for a Union Station for the Swiss Railways at St. Gall. (Das Umbau Projekt der Vereinigten Schweizerbahnen für den Bahnhof St. Gallen.) With plan showing the approaches and track connections, as well as the relation to the city, together with a profile of grades. 2500 w. Schweizerische Bauzeitung—Dec. 25, 1897. No. 17837 B.

TRANSPORTATION.

Accidents.

Do Railways Deserve Credit or Blame for the Number of Lives Lost in Their Operation? E. P. Ripley. Extract from a letter to the public dealing with the subject of railway accidents. 4500 w. Ry Age—Jan. 21, 1898. No. 17974.

Train Accidents in the United States in November. Detailed list with classified summary and comments. 4400 w. R R Gaz—Dec. 31, 1897. No. 17488.

Train Accidents in the United States in December. Detailed list and classified summary. 4500 w. R R Gaz—Jan. 28, 1898. No. 18060.

Earnings.

Satisfactory Railroad Earnings. The month of December shows very favorably. Tabulated reports of increases and decreases are given. 700 w. Bradstreet's—Jan. 15, 1898. No. 17743.

England.

"Long and Short Haul" in England, W. M. Acworth. States the facts to correct a misunderstanding of English practice, as given in the report of the Interstate Commerce Commission. 1000 w. R R Gaz—Jan. 21, 1898. No. 17955.

Interstate Commerce.

Demanding a Dangerous Privilege. Thomas P. Grasty. Claims that the ambition of the interstate commerce commission menaces the South and the country at large. 2000 w. Mfrs Rec—Jan. 14, 1898. No. 17733.

Pooling.

Pooling Locomotives and Locomotive Crews. J. F. Deems. Abstract of paper presented at meeting of the Western Railway Club. Explains the system of handling engine crews known as "pooling," with evidence of its worth, based on testimony of those who have tried it. 2800 w. Ry & Engng Rev—Jan. 22, 1898. No. 18022.

Should Congress Legislate on the Subject of Railway Rates? Aldace F. Walker. Extracts from a synopsis of a paper. Also editorial. Considers the constitutional right, the practical common sense, the demand for additional power in this direction, etc. 7000 w. R R Gaz—Jan. 7, 1898. No. 17563.

Rates.

Railroad Rates in Kansas. Abstracts of some portions of an open letter by E. P. Ripley, of the Atchison, Topeka & Santa Fe Ry., bearing upon railway rates and methods used by anti-railroad agitators. 5500 w. Ry & Engng Rev—Jan. 15, 1898. No. 17931.

The New Russian Grain Rates. Explains the new schedule of rates and comments on its importance to farmers and carriers of the United States. 1500 w. R R Gaz—Jan. 21, 1898. No. 17958.

Traffic Review of 1897. Editorial review of events affecting rates of traffic in various parts of the United States. 1700 w. R R Gaz—Jan. 14, 1898. No. 17750.

Speeds.

Railway Maximum Speeds. Charles Rous-Marten. Reports personal investigation of English locomotive speeds since 1894 and expresses disbelief in the records claimed for American locomotives. 2000 w. Engr, Lond—Dec. 31, 1897. No. 17696 A.

Ticket Brokerage.

The Anti-Scalping Bill. Editorial report of the statements of George W. Boyd of the Pennsylvania Road, and Messrs Daniels, King and Dill. 1400 w. R R Gaz—Jan. 14, 1898. No. 17749.

MISCELLANY.

Acceleration.

Comparative Rates of Acceleration. George L. Fowler. Gives a diagram showing the comparative rates of acceleration of the Schenectady experiments and those obtained by the writer, with conclusions. 1100 w. R R Gaz—Jan. 21, 1898. No. 17956.

Engineering Work.

The Illinois Central Improvements at Chicago. Illustrated description of the work of track depression and rearrangement of terminal yards, bulkhead work, viaducts, &c. 4300 w. R R Gaz—Jan. 28, 1898. Serial. 1st part. No. 18059.

Finances.

Receiverships and Foreclosure Sales in 1897.

A remarkable decrease. No year since 1887 has shown so few roads or so small mileage confessing insolvency. 900 w. Ry Age—Dec. 31, 1897. No. 17538.

India.

Indian Railway Property. Review of the experiences of the year, which were greatly affected by the pestilence, famine and war in some districts. 1300 w. Engng—Dec. 24, 1897. No. 17610 A.

Land Slides.

Land-Slides on the Canadian Pacific Railway. Robert B. Stanton. Abstract of paper read at meeting of the Inst. of Civ. Engs., England. Describes these slides and discusses the causes. 1000 w. Engng—Jan. 7, 1898. No. 17787 A.

Public Attitude.

The Public Attitude Toward Railways. From an address by J. T. Brooks of the Pennsylvania Railroad, at Purdue University. Considers watered stock; what justifies stock issues; uniformity of rates; competition and discrimination; causes of discrimination; and the public attitude towards pools. 5000 w. Ry Age—Jan. 14, 1898. No. 17771.

Railway Statistics.

The Official Statistics of the Railways of the United States in 1896. Abstracted matter from advance copy of the ninth annual report of the Interstate Commerce Commission's Statistician. 2000 w. Eng News—Dec. 30, 1897. No. 17482.

Report.

Abstract of Report: Board of Railroad Commissioners State of New York. Interesting abstracted matter relating to the condition of the roads, earnings, expenditures, improvements, equipment, &c. 3500 w. Ry & Engng Rev—Jan. 22, 1898. No. 18023.

New York Railroad Commissioners' Report. Review of this report which gives statistics for the year to June 30, 1897. 2000 w. R R Gaz—Jan. 21, 1898. No. 17954.

Reversing.

To Reverse or Not? M. E. On the different opinions held regarding the advisability of reversing the engine in time of danger. 1400 w R R Gaz—Dec. 31, 1897. No. 17484.

Station.

The Wettin Street Railway Station in Dresden. (Die Haltestelle Wettinerstrasse in Dresden.) Illustrated account of this fine new "through" railway station. The train shed has single braced arch roof 152 ft. span by 350 feet long. Two articles. 3500 w. Deutsche Bauzeitung—Dec. 18, 22, 1897. No. 17841 E.

Trolley Rivalry.

Connecticut Steam Trolley Rivalry. Reviews the measure of success attained by the third-rail system, reports extension proposed, and discusses the subject generally. 1200 w. R R Gaz—Jan. 14, 1898. No. 17751.

STREET AND ELECTRIC TRAMWAYS.

Aix-la-Chapelle.

Electric Tramway in the Suburbs of Aix la-Chapelle (Elektrische Kleinbahn in Landkreis Aachen.) Describes a system of over 30 miles of suburban electric road connecting Aix-la-Chapelle, Stolberg, Eschweiler, and Alsberg. Serial. Part I. 2500 w. Ill. Zeitschr f Klein u Strassenbahnen—Jan. 1, 1898. No. 17859 D.

Brooklyn Bridge.

The Use of the Brooklyn Bridge by the Transportation Systems of Brooklyn. An explanation of the first and the revised plans, and other complications. 1500 w. St Ry Jour—Jan., 1898. No. 17646 D.

Car Tracks.

Substructure of Street-Car Tracks, Buffalo, N. Y. Illustrates system of 60-ft. rails on longitudinal concrete beams. 300 w. Eng Rec—Jan. 8, 1898. No. 17658.

Changed Power.

Changing a Cable Conduit to an Electric Conduit. Illustrated description of the work in Washington, D. C., of replacing the cable with the underground electric system. 1300 w. St Ry Jour—Jan., 1898. No. 17645 D.

Conduit Roads.

Underground Conduit Electric Roads in America. Reviews the progress of electric conduit roads in the United States, giving brief accounts of a number of failures and of the successful roads. 1800 w. St Ry Rev—Jan. 15, 1898. No. 17775 C.

Dublin Tramways.

Electric Tramways in Dublin. Clontarf Section. Illustrated detailed description. 2000 w. Elec Rev, Lond—Dec. 24, 1897. No. 17597 A.

Efficiency.

The Efficiency of Tramway Motors. (Ueber den Wirkungsgrad von Strassenbahnmotoren.) E. G. Fischinger. The results of a number of tests are given, with tables and curves; the action of the gearing is especially considered, also the lubricants. Oil is preferred to grease for this service. 1500 w. Elektrotech Zeitschr—Dec. 23, 1897. No. 17863 B.

Electric Locomotive.

The Heilmann Electric Locomotive (La Locomotive Electrique. Système J. J. Heilmann.) A detailed description, with illustrations of the completed machine as well as the engines and motors, and an account of the preliminary trials. 2500 w. 1 plate. La Revue Technique—Dec. 25, 1897. No. 17822 D.

Employes.

Discipline of Employes. An explanation of the system of the Metropolitan West Side Elevated Railroad Company, of Chicago, which is based on the percentage classification. 1500 w. St Ry Rev—Jan. 15, 1898. No. 17778 C.

Germany.

Statistics of the Electric Tramways in Germany. (Statistik der Elektrischen Bahnen in Deutschland.) An elaborate tabulated view of

the electric roads of Germany, giving location, gauge, system, capacity and other details. 10000 w. Elektrotech Zeitschr—Jan. 6, 1898. No. 17869 B.

Haulage.

See Mining and Metallurgy, Mining.

Ireland.

Electric Railways in Dublin and Cork. Illustrated description of the Clontarf section, Dublin, which has recently been electrically equipped; also an account of the electric railways of Cork. 2000 w. St Ry Jour—Jan., 1898. No. 17643 D.

Jungfrau.

The Jungfrau Railway. (Die Jungfraubahn.) F. Hennings. A general description of the plans for the electric-rack railway to the summit of the Jungfrau, with a statement as to the present condition of the work. 3000 w. Zeitschr d Ver deutscher Ing—Dec. 25, 1897. No. 17803 D.

Locomotive.

See Railroad Affairs, Maintenance of Equipment.

Management.

Municipal Tramway Management. A comparison of the corporation-worked tramways of Leeds, Eng., with a tramway in the hands of a private company, and a discussion of the service and means of benefitting it. 3300 w. Ry Wld—Jan, 1898. No. 17915 A.

Motors.

Some Applications of Alternating Motors. Albert Gould Davis. Considers the advantages and disadvantages of alternating motors, the question of speed regulation, and their use in long-distance electric railway work. Ill. 3500 w. Elec Wld—Jan. 1, 1898. No. 17525.

The Use of Polyphase Motors on Electric Railroads. Charles Proteus Steinmetz. Discusses the use for the operation of railroad cars, reviewing the three methods for controlling polyphase railway motors, and comparing the relative advantages of polyphase and continuous-current motors. 2000 w. Elec Wld—Jan. 1, 1898. No. 17522.

Rail Bonding.

Railway Bonding. Walter E. Harrington. An outline of tests with conclusions favoring the Edison-Brown Bond. 900 w. Jour Fr Inst—Jan., 1898. No. 17651 D.

The Evolution of the Rail Bond. Harold P. Brown. Traces the development of these bonds as shown by the patents issued, and by the records of practical work. Ill. 2500 w. Elec Wld—Jan. 1, 1898. Serial. 1st part. No. 17526.

Railway Raising.

Raising a Chicago Elevated Railway. William M. Christie. Illustrated account of the raising of the South Side Elevated Railway. 2000 w. Eng Rec—Jan. 22, 1898. No. 17962.

Repairs.

Cutting Down the Cost of Electrical Repairs of Railway Motors. M. R. McAdoo. Explains a system of simple electrical tests which will indicate electrical weaknesses. Ill. 1800 w. St Ry Jour—Jan., 1898. No. 17644 D.

Repair Shop of the Chicago City Railway. Illustrated description of shop, tools, &c. 3600 w. St Ry Rev—Jan. 15, 1898. No. 17777 C.

Storage Batteries.

Storage Batteries as Station Auxiliaries in Pittsburgh. An illustrated description of the storage battery plants adopted, and some of the results secured in economy. 1700 w. St Ry Jour—Jan., 1898. No. 17642 D.

Electric Storage Battery Cars on the Englewood and Chicago Electric Railway. An account of the railway which employs this system exclusively. Ill. 3300 w. Eng News—Jan. 6, 1898. No. 17571.

Street Railways.

Relations of Street Railways and Municipal Corporations. Everett W. Burdett. Portion of argument in closing the investigations by special committee in Massachusetts, giving the points of widest interest. 10000 w. St. Ry Rev—Jan. 15, 1898. No. 17776 C.

Traction.

Remarks Upon Long-Distance Distribution for Electric Traction. André Blondel. Describes a method which operates on the principle of feeding the cars by a series distribution of constant current without the necessity of operating any switches or commutators upon the line by the passage of the trains. 2500 w. Elec Wld—Jan. 1, 1898. No. 17523.

Some Difficulties of Heavy Electric Railroading. Louis Bell. Considers the possible limitations. Discusses economy of operation, repairs, labor, etc., danger of breakdown of the system from accident, voltage, &c. in part first. 3000 w. Elec Wld—Jan. 1, 1898. Serial. 1st part. No. 17524.

Tramway Construction.

Recent Electric Tramway Construction in England. Harold Lomas. Part first gives a summary of the more important rules applying to the overhead-trolley system, with a brief history of electric traction in England, Ill. 1800 w. Elec Wld—Jan. 29, 1898. Serial. 1st part. No. 18070.

The Possibilities and Limitations of Electric Traction. Frank J. Sprague. The concluding article emphasizes the value of the multiple unit system and asserts that motors or motor combinations can be built which will surpass in power, and in tractive and speed capacities, any locomotive which it is practicable to construct and operate. 2800 w. Engineering Magazine—February, 1898. No. 18076 B.

Tramway Power.

Tramway Power from Lighting Stations. What is a fair price to charge is considered. The conclusion reached is that in the neighborhood of coal fields, the charge for power should not exceed three half-pence per unit, and should many times be less. 2500 w. Ry Wld—Jan., 1898. No. 17916 A.

BOOKS OF THE MONTH

ENGINEERING AND ARCHITECTURAL JURISPRUDENCE. A Presentation of the Law of Construction, for Engineers, Architects, Contractors, Builders, Public Officers, and Attorneys at Law. By John Cassan Wait. M. C. E, LL. B. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898.

The relations of engineering and architecture to jurisprudence are such as to make the practice of this branch of law a difficult and unsatisfactory one to both parties unless some especial training is had.

Attorneys at law are very often unfamiliar with the peculiarities and difficulties accompanying construction work, and in the examination of experts they are frequently lacking in the technical knowledge or even the command of scientific terms to an extent which prevents them from making the most of the case.

The same is true even in a greater degree as regards the unfamiliarity of engineers with the rules of evidence and court procedure, and they often make suggestions which are shortsighted and impracticable.

It is for the aid and instruction of both engineer and lawyer that Mr. Wait has prepared this important and valuable work, and from the fact that he is at the same time a trained engineer and a specialist in the practice of this branch of law, he is especially competent to execute the task in a thoroughly acceptable manner.

The author especially disclaims any intention of assuming that a few weeks or months study of text books can fit the engineer to practice or give advice in this branch of law, but a knowledge such as can be attained in this manner will often assist him in avoiding trouble and litigation, and aid him in protecting his employer's and his own rights when they are assailed.

To quote from the author's preface:

"It is hoped that the book will fulfill another mission—that of guiding and strengthening the younger and inexperienced members of the industrial professions in a proper understanding and appreciation of business and business relations. Young men in the engineering and architectural professions often obtain in their technical school training a contracted view of their professional duties and labors. They are likely to narrow their professional work to the ministerial duties of the drafting room, the shop or the field. Too many well trained and educated men remain in the shop or drafting room, while less skillful men from the accounting room and office, but with a good business experience become superintendents, managers, and presidents of the concerns employing them; and it should be said that frequently the latter, are more justly entitled to the place. The education of the engineer should fit him for a higher sphere than that of a delineator of lines. Supplemented with a good business experence, his training eminently fits him for the direction and superintendence of large works; and that is his proper field."

The work contains a large number of contract stipulations selected from a collection of many thousand, and many forms and precedents for almost every imaginable variety of work are given. As a work of reference the book is a valuable addition to the library of both lawyer and engineer, while to all who may be engaged in contract or construction work it will certainly be found most useful.

A FIELD MANUAL FOR RAILROAD ENGINEERS. By J. C. Nagle, M. A., M. C. E. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1897.

Professor Nagle has prepared a very handy little field book for the railroad engineer, closely limited to the actual needs in the field, and yet so arranged that it may be used as a text-book in the classroom. After chapters on "Reconnoissance," "Preliminary Surveys," and "Location," the subject of "Transition Curves" is taken up, the rigid method of Prof. Crandall being adopted, and simpler approximate methods being also given,

with their limitations indicated. The subject of "Frogs and Switches" is also discussed at length, and a chapter on "Construction" closes the work. An appendix of tables is given, among which may be noted the table of functions of a one-degree curve, from which the functions for other curves may be taken under the assumption that they vary inversely as their degree or directly as their radii. The error from this assumption will, in any practical case, amount to no more than a few tenths or hundredths of a foot. The book will doubtless be found a handy field companion for the locating engineer, especially if he has used it in the class-room.

AMERICAN RAILWAY MANAGEMENT. Addresses Delivered before the American Railway Association, and Miscellaneous Addresses and Papers. By Henry S. Haines. New York: John Wiley and Sons. London: Chapman and Hall, Limited, 1897.

This volume contains a collection of addresses by the former vice-president and general manager of the Plant system of railway and steamship lines, upon such subjects as train rules, safety appliances, cost of transportation, labor organizations, operating expenses, freight rate classification, and many other matters of especial importance to railroad men and of general interest to the public at large.

Delivered, as most of these addresses were, to an assemblage of railroad men it is to be expected that such subjects as safety appliances, car couplers, labour organizations, and the like would be treated from the point of view of the railroad management; but in all cases there is manifested a disposition of fairness and correct insight which makes them interesting reading to all. Many of the papers contain statistics and data relative to railroading in America which are discussed in a manner enabling the general management of American railways to be grasped and understood by laymen of all countries, and in view of the present international interest in the relative cost of merchandise transportation in different countries the book is timely and valuable.

BOOKS RECEIVED.

The Planning and Construction of High Office Buildings. By William H. Birkmire. New York: John Wiley & Sons. London: Chapman & Hall, Limited.

The Proceedings of the Chemical and Metallurgical Society of South Africa. May, 1894—January, 1897. Vol. I. Edinburgh: R. W. Hunter. Johannesburg, S. A. R. The Chemical and Metallurgical Society of S. Africa.

High Masonry Dams. By E. Sherman Gould. Van Nostrand's Science Series, No. 22. New York: D. Van Nostrand Co.

Whittaker's Mechanical Engineer's Pocket Book. By Philip R. Bjorling. London: Whittaker & Co. New York: The Macmillan Company.

The Automotor and Horseless Vehicle Pocket Book of Automotive Formulæ and Commercial Intelligence for 1898. London: F. King & Co.

Placer Mining. A Handbook for Klondike and other Miners and Prospectors. Scranton: The Colliery Engineer Company.

Introductory Course in Mechanical Drawing. By J. C. Tracy, M. E. With chapter on perspective by E. H. Lockwood, M. E. New York and London: Harper & Brothers.

American Gazetteer of Power Plants in the Principal Cities and Towns of Pennsylvania for the year 1897. Cleveland: Compiled and Published by the American Gazetteer Co.

Hendricks' Architects', Builders', Contractors' and Manufacturers' Directory of America. New York: Samuel E. Hendricks Co.

Preliminary Survey and Estimates. By Theodore Graham Gribble. Second Edition. London, New York, and Bombay: Longmans, Green and Co.

The Gas World Year Book, 1898. Edited by John Douglas. London: John Allan & Co.

Machine Design. Part I. Kinematics of Machinery. By Forrest R. Jones. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

Eighteenth Annual Report of the United States Geological Survey. Charles D Walcot, Director. Part V. Mineral Resources of the United States, 1896. Metallic Products and Coal. Washington: Government Printing Office. 1897.

Commercial Directory of the American Republics. Compiled by the Bureau of American Republics. Joseph P. Smith, Director. Washington: Government Printing Office. 1897.

The Power Catechism. By F. R. Low. New York: The Power Publishing Co. 1897.

Mechanical Draft. A Practical Treatise. B. F. Sturtevant Co. Boston, Mass.

The Purpose of Textile Education. An Address at the Lowell Textile School. By C. J. H. Woodbury. Waltham, Mass.: Ephraim L. Barry. 1897.

Proceedings of the Fifth Annual Convention of the Traveling Engineers' Association. W. O. Thompson, Secretary. Elkhart, Indiana: Review Printing Co. 1897.

NEW CATALOGUES AND TRADE PUBLICATIONS.

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

The Ingersoll-Sergeant Rock Drill Company, New York.=Condensed edition of catalogue of Air-Compressors, containing illustrations of various types of compressors, with addresses of some of the users of these well-known machines. A very convenient little book for reference, and furnished on application to the company.

Henry Maurer & Son, 420 E. 23d St., New York=Illustrated catalogue of fire-proof building material for 1898. Several novel features in the line are shown which will interest engineers as well as architects. Their new Eureka arch, for light floor construction, is fully described and illustrated, and is strongly commended for fire-proofing where lightness of construction is desirable.

The Michigan Pipe Co., Bay City, Michigan, U. S. A. Manufacturers of Creosoted Wood Conduits for underground wires. = Illustrated pamphlet descriptive of the Bethell process of preserving timber by the use of creosote oil. Useful information is given about processes for preserving wood for various purposes, making the catalogue suitable for filing and reference.

Earle C. Bacon, Havemeyer Building, New York. Hoisting Engines, Mining Machinery, etc.=A description with many illustrations, of Bacon's hoisting engines, cableways, and winding engines, together with a general list of boilers, engines, pumps, pulleys and miscellaneous machinery, the whole forming a useful reference catalogue.

E. C. Atkins & Co. (Incorporated), Indianapolis, Ind. U. S. A.=A very complete and fully illustrated catalogue of saws and saw mill specialties, including circular and band saws, as well as cross-cut and hand saws, mandrels, dogs, and sharpening devices.

The J. M. Carpenter Tap & Die Co., Pawtucket, R. I., U. S. A.=Catalogue No. 12, of taps, dies, and threading tools of all kinds. About 5,000 sizes and kinds of screw-cutting tools are listed in this book in an admirable manner, in clear type, with blank line between each line of type.

The Q & C Company, Chicago, Ill., U. S. A. =Catalogue C and D, car door equipment and general railway specialties; catalogue E, the Q & C Scott Boiler Feeder. The latter contains useful information in connection with the question of steam consumption for boiler-feeding purposes.

Kutztown Foundry and Machine Co. (Incorporated).=Catalogue of the Rose Patent Grate, with directions for use, and extensive list of users.

The Railroad Supply Company, Chicago, Ill., U. S. A.=Defects of M. C. B. Couplers, and Their Cures. A few notes on the weak points of the present M. C. B. Couplers as commonly used, with illustrated description of the Hien Double Automatic Coupler and the manner in which it is intended to overcome such defects.

Easton & Bessemer, Ltd., Taunton, England. =Small illustrated price-list of engines, boilers, woodworking and grinding machinery, hydraulic pumps, and presses, with dimensions, weights, and prices of all machines illustrated.

Gandy Belt Mfg. Co., Ltd., 97 Queen Victoria St., London.=(*a*) Small paper-covered price list of belting and belting accessories, with maximum and minimum sizes of leather, cotton, hair, link, rawhide, and other varieties of belting; also particulars of rubber suction hose, valves, etc.; (*b*) price-list, in sheet form, of the "Dodge" wood split pulleys with instructions for telegraphic ordering.

The Reliance Lubricating Oil Co., 19 Water Lane, Great Tower Street, London.=Price-list of non-corrosive lubricants, with some remarks as to particular uses of the several kinds; also description of the Boverton Redwood, and the Coleman archbutt viscometers.

Arthur Koppel, 78–80 Broad St., New York.= A full list of materials for narrow-gage railway construction and operation, manufactured at Bochum, Camen, and Wolgart, in Prussia, and especially adapted for portable and mining railways, or for contractor's or plantation work. The catalogue is printed in English and Spanish, is very fully illustrated, and contains a special telegraph code for both languages.

Queen & Boulding, 21 Featherstone St., London.=Catalogue of the Buffalo injector, the Buffalo steam-jet pump adapted for raising water from deep wells, and of the "Tripp" metallic packing. The catalogue is fully illustrated and well printed, and gives usual information as to dimensions and prices. Some information regarding the Shipman petroleum engine and miscellaneous fittings, such as valves and flue-cleaners, is included.

Bever & Dorling, Dewsbury Foundry, Dewsbury, England.= *a)* List of friction clutches and couplings, with full description prices, and illustrations; (*b*) price-list of friction clutches, dealing with their application to wire rope haulage, of wrought iron pulleys, and of Gill's patent haulage clip; (*c*) price list of duplex pumps, with details of special advantages claimed, full dimensions, and prices.

The Vulcan Iron Works Co., Toledo, Ohio, U. S. A.=Catalogue of "Giant" and "Little Giant" Excavators, with excellent elevations and plans of various excavators and steam shovels, and specifications of details.

Boston Belting Co., Boston, Mass., U. S. A. =Catalogue of cotton and rubber garden hose, couplings, nozzles, sprinklers, reels, &c., with prices.

Hill & Smith, Brierley Hill Iron Works, Dudley, England.=Illustrated price-lists; (*a*) garden rollers, lawn mowers, and other horticultural requisites; (*b*) corn bins, galvanized-iron tanks, cisterns, and agricultural feeding appliances; (*c*)

iron sheds and roofing for agricultural purposes; (*d*) abridged catalogue of patent continuous iron fencing; (*e*) leaflet illustrating ornamental wrought-iron band stands; (*f*) approximate price list of forgings up to 15 tons in weight; (*g*) price-list of housing pens and boxes for rolling mills; (*h*) beautiful photo book of hammered copper and iron ornamental art work. In all these price-lists concise information is given.

Clayton & Co., Atlas Works, Harrow Road, London.=(*a*) Comprehensive 40-page illustrated catalogue of brick, tile, and pipe machinery, with some statements of the operation, approximate weights, and capacities of the machines; (*b*) eight-page price-list, including prices of steam engines and boilers.

Herbert W. Periam, Floodgate Street Works, Birmingham, England.=Illustrated price-list of screws, rivets, and washers for engineers' use.

Fraser & Chalmers, Chicago, Ill., U. S. A. =Circulars, No. 25, 26, and 31, describing respectively the "Comet" adjustable gyratory crusher; the "New" Blanton self-tightening cam; and the "Otto" aerial tramway.

Stow Manufacturing Co., Binghamton, New York, U. S. A.=Illustrated catalogue of flexible shaft, with description and prices of many special tools for use in drilling, tapping, reaming, grinding, polishing, &c.

General Electric Co., Schenectady, New York, U. S. A.=Edison Incandescent Lamp catalogue, special reprint pamphlet of information for users of incandescent lamps.

John Wild & Co., Ltd., Falcon Ironworks, Oldham, England.=Ten-page fully-illustrated catalogue of colliery-engine plant, including portable and fixed hauling and winding engines, steam and electrical pumps, boilers, and steam engines. Horse powers, dimensions, and prices are briefly, but clearly, stated.

Richard Schram & Co., Cannon Street House, London.=(*a*) Neatly-printed illustrated catalogue of air compressing and rock-boring machinery, giving full description and results of lists of air compressors. Special attention is given to the new "Optimus" compound rock drill and to the "Root" water-tube boilers; (*b*) leaflet of hand-power diamond prospecting machine.

H. I. H. King & Co., Nailsworth, England.= "Engine" catalogue dealing with the King patent vertical compound, Corliss, compound non-condensing, compound Corliss, and tri compound Corliss engines; cylinder diameters and other dimensions are given, but not prices. Information on the Worthington self-cooling condenser and the King air pump is included.

Edison & Swan United Electric Light Company, Ltd., London =Handsome illustrated catalogue (section 6) of the "Ediswan" electric-light fittings, with prices.

Bowes, Scott & Western, Broadway Chambers, Westminster, London =Cloth-covered comprehensive catalogue of mining machinery, with very complete index. Practically all types of machinery in general use for metalliferous mining and smelting are included. Very fully illustrated, with concise descriptive matter.

Conrad Knap & Co., Ltd., London.=Cloth-covered catalogue of water-tube boilers, heaters, and Root's patent acme blowers; full descriptions and sectional drawings are given. Injectors and general steam fittings are also described.

Drake & Gorham, 66 Victoria St., London.= (*a*) Handsome cloth covered catalogue of electric lighting plants and accessories, including accumulators, switches, and incandescent lamps; (*b*) list of electric-light installations erected by this firm, giving class of motive power employed and the number of lights used; (*c*) excellently-printed catalogue of the "Jandus" arc lamp, with a large number of half-tone illustrations taken from actual plants; also instructions for mounting and trimming the lamp.

The Litholine Co., 32 Victoria St., Manchester, England.=Pamphlet relating to the use of litholine in preventing boiler corrosion and incrustation, with copies of testimonials from users.

Charles Thompson, Grantham, England.= Small pamphlet describing the Thompson "Universal" conveyor used for grain, barley, etc.

Beauland Perkin & Co., Leeds, England.= Pamphlet entitled "Some Observations on Enclosed Globe Arc Lamps," with special reference to the "Ajax" lamp sold by this firm; a price-list of the lamps is appended.

E. Green & Son, Ltd., 2 Exchange St., Manchester, England.=Very handsome paper-covered catalogue describing in great detail the Green fuel economiser, with illustrations of all parts and folding plates showing sectional drawings and affording hints in the design of steam plants; describes also the "Merithort" boiler and economiser feed pump. Tables and tests of the economy of the Green system are appended.

F. L. Hansell & Co., Eyre Lane, Sheffield, England.=Nine large sheets making a fully-illustrated list of steel castings, principally Sheffield steel wheels and axles, but also picks, shovels, hammers, blacksmiths' tools, steel barrows, gearing, and other similar lines.

Richard Garrett & Sons, Leeston, Suffolk, England.=40-page illustrated catalogue, devoted principally to portable steam engines and boilers, with several pages devoted to stationary engines, hauling engines for mining work, and the Turner-Hartnell patent governor.

Muntz's Metal Co. Ltd.=Handsome leather-bound pocket-book giving weights and thickness of copper tubes and a variety of valuable tables on seamless drawn copper tubes. Tables and information are given of sizes, weights of copper rods, brazed copper tubes, and bolts.

The Farnley Iron Co., Ltd., Leeds, England. =Large atlas giving diagram of rolled sections with sizes and weights in the English and metric systems; also information on boiler and flanged plates made of "Farnley" iron, the basis of which is the cold blast pig made by the firm.

C. Whittaker & Co, Accrington, England.= (*a*) Illustrated catalogue of clay-working and brick-making machinery, including grinding mills, mixers, presses, sieves, etc. The catalogue is well printed, and is in a cloth cover, weights, measurements, and capacities of the machines being given; (*b* leaflet illustrating and describing the Whittaker semi-plastic brick-making machine.

For additional **Catalogues**, *see page 30.*

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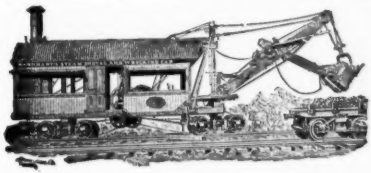

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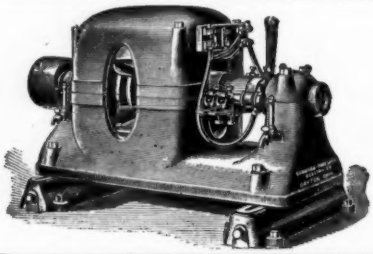

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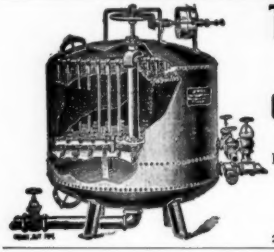

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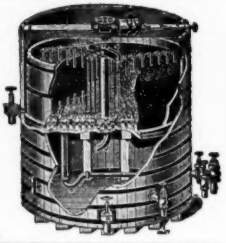

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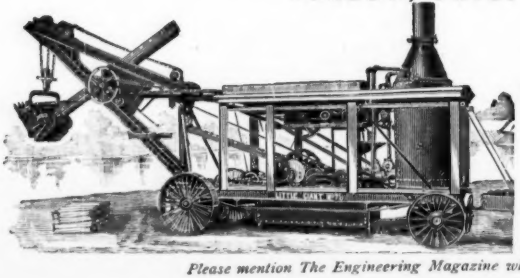

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AUTHORS AND PAPERS FOR MARCH.

JOHN HAYS HAMMOND (*The Gold Mines of the Witwatersrand, South Africa*)=Graduated at Yale University in 1876; completed his mining course at Freiberg 1876 to 1879, afterwards spending a year in traveling through the mining districts of the western United States; was appointed special expert on the United States Mining Survey in 1880, and subsequently engaged for several years as mine manager in Mexico and California and as consulting engineer to the Union Iron Works, San Francisco, Cal.; during the period prior to his departure for South Africa in 1893, he acted also as consulting engineer to the Southern Pacific Railway. In 1893 he went to South Africa under engagement by the British South African Chartered Company, to make an examination of the mining resources of Rhodesia. Since 1895, he has been consulting engineer to the Consolidated Gold Fields of South Africa, Limited. Mr. Hammond's articles in THE ENGINEERING MAGAZINE, together with those by his associates to follow, constitute the first authoritative exposition of one of the world's greatest mining fields.

ROSSITER WORTHINGTON RAYMOND (*Mining Law in British Columbia, Mexico, and the United States*)=Born 1840, at Cincinnati, O.; studied at Brooklyn Polytechnic Institute, and at the Universities of Heidelberg and Munich, and the Mining Academy of Freiberg, in Germany; has been in practice as mining engineer and metallurgist since 1863; was for many years editor of the *Engineering and Mining Journal;* for several years a member of the faculty of Lafayette College (lecturing on ore-deposits); from 1868 to 1876 United States Commissioner of Mining Statistics; in 1872, '3 and '4, president, and since 1883, secretary, of the American Institute of Mining Engineers. Author of numerous essays, papers, and articles in magazines and cyclopædias on mining, metallurgy, and mining law.

BRYAN DONKIN (*The Economical Utilization of Exhaust Steam*)=Born in London, 1835; educated in various London schools and in University College, London, and the Ecole Centrale, Paris. Erected his firm's works about 1857, and a large paper mill at St. Petersburg for the Russian Government 1859-1862; in 1867 he became a partner in Bryan Donkin & Co., and later, chairman of Bryan Donkin & Co., Ltd. He has made many experimental researches in engine and boiler problems—condensation of steam, temperature of cylinder walls, transmission of heat, etc.; has contributed many papers during the last fifteen years to the I. C. E. and I. M. E.; was some years ago elected to the Council of the I. M. E.; he is a member of the Royal Institution, the British Association, and the Verein Deutscher Ingenieure; member of several committees of the I. C. E. and I. M. E.; recipient of the Watt gold medal and Manby premium from the I. C. E.; author of a book on Gas, Oil, and Air Engines.

JAMES McKECHNIE (*Ship-Building as a Productive Industry in Great Britain*)=Manager of the engineering works at the great establishment of Messrs. Vickers, Sons & Maxim, Barrow-in-Furness—a position which he has held for fully two years, and for which he has had an admirable training, having passed through all departments in the drawing office and shops, not only of marine, but of other mechanical-engineering works. He held positions of responsibility at Fairfield and Messrs. Thomson's of Clydebank during the construction of several of the ocean "greyhounds," being associated with the design of the machinery of some of the latest. For five years prior to going to Barrow he was engineering manager to the Nervion Works, near Bilbao, where he designed and constructed machinery for three belted

cruisers, which attained speeds of 20 to 20½ knots, and for this service he was decorated by the King of Spain with the Grand Cross and Star as Knight Commander of the Ancient Royal Order of Isabel la Catolica.

F. C. MOORE (*The Construction of Slow-Burning Buildings*)=President of the Continental Insurance Company, of New York, with which he has been associated for nearly thirty years. He was chairman of the committee which prepared the "Universal Mercantile Schedule," and is a delegate from the New York Board of Fire Underwriters to the Board of Examiners of the Building Department. He is the author of several books—"Fire Insurance and Causes of Fires," "Economical Fire-Resisting Construction," "Water-Works and Pipe Distribution," and "How to Build a Home."

WILLIAM JAMES STEVENS (*British Railway Fares and their Influence on Traffic*) =Formerly in the service of the English Railway Clearing-House and the audit department of the London & Northwestern Railway; author of "Home Railways as Investments"; a contributor to the *Economist*, the *Railway Times*, *Financial Times*, and other financial papers in London, on railway matters; he has studied especially all matters connected with English railway finance and also published a pamphlet on railway capital expenditure.

ELWOOD MEAD (*The Adjudication of Water Rights in Irrigated Regions*)=Born in Indiana in 1858; was a deputy county surveyor at seventeen; graduate of Purdue University in both the scientific and agricultural courses; post-graduate of Iowa Agricultural College in civil engineering; United States assistant engineer in the survey and improvement of Wabash river in 1882; professor of mathematics, Colorado Agricultural College, 1883-84; assistant State engineer of Colorado, 1885-86, and professor of irrigation engineering, Colorado Agricultural College, 1887. Territorial and State engineer of Wyoming, 1888 to the present time; consulting engineer on many of the largest irrigation and water works projects in the West.

OBERLIN SMITH (*The Development of Machinery for Metal Stamping*)=President of the Ferracute Machine Company of Bridgeton, New Jersey, U. S. A. Past President of the American Society of Mechanical Engineers; author of a treatise upon the "Press Working of Metals"; a well-known and acceptable writer upon a wide range of mechanical and engineering subjects, and an experienced authority upon the subject of stamping and drawing metals.

A. HUMBOLDT SEXTON (*Methods for the Recovery of By-Products of the Blast Furnace*)=Born in London in 1853; educated at the Royal School of Mines, London, and at the Royal College of Science, Dublin, where he held a scholarship; in 1873 became assayer and assistant to the manager at the Ballycross Lead Works, Dublin, and afterwards entered the service of the Broughton Copper Co., Manchester, as chemist; in 1881 was appointed science master at the Burslem School of Science and Art, and in 1883 became lecturer on chemistry and metallurgy at the Manchester Technical School; in 1884 was appointed to the chair of chemistry in the Glasgow College of Science and Arts; in 1887, the college was amalgamated with Anderson's College and some other institutions to form the Glasgow and West of Scotland Technical College, and he then took the chair of metallurgy in the new college, which he still holds; for the last twelve years has devoted himself to the study of metallurgy, mainly in connection with iron and steel and gold and silver, and has done a large amount of experimental work in connection with various processes. He is President of the West of Scotland Iron and Steel Institute, Member of Council of the Glasgow Philosophical Society, Fellow of the Chemical Society and the Institute of Chemistry, Member of the Institution of Mining and Metallurgy, Society of Chemical Industry, Society of Engineers and Shipbuilders in Scotland, etc., etc.

F. C. FINKLE (*The Electric Development of Hydraulic Power*)=Born May 3, 1865, at Viroqua, Wisconsin; took academic course at the Viroqua High School, and afterwards studied civil engineering at the University of Wisconsin, Madison, Wisconsin, and the University of Leipsic, Leipsic, Germany. He began the practice of civil engineering as a transitman on irrigation work in New Mexico, went to southern California in 1887 and was employed on surveying work near Los Angeles until November, 1887, when with W. C. Parmley he opened an engineering office in San Bernardino, California, under the firm name of Parmley & Finkle. This firm were chief engineers of the Jurupa canal, and carried on a general practice in hydraulic and irrigation engineering. Since 1890 Mr. Finkle has acted as chief engineer of the new water works for the city of San Bernardino, the East Riverside Irrigation District, and the Grapeland Irrigation District; at present he is chief engineer of the Electric Power Company of Los Angeles, California, and of the Lytle Creek Light and Power Company of Redlands, California, which positions he has held since the beginning of work by these companies in 1896.

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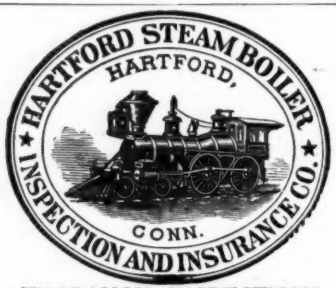

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Link-Belt Engineering Co., Philadelphia, Pa.

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Harrington & King Perforating Co., Chicago, Ill.

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Morse, Williams & Co., Philadelphia, Pa.
Triumph Electric Co., Cincinnati, Ohio.
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Atlantic Works, East Boston, Mass.

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A. B. Bowers, San Francisco, Cal.
Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, New York.
Vulcan Iron Works, Toledo, Ohio.

Exhause Heads.
A. A. Griffing Iron Co., 66-68 Center St., New York.

Fans, Ventilating.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.

Feed-Water Heaters.
A. A. Griffing Iron Co., 66-68 Center St., New York.
Edw. P. Allis Co., Milwaukee, Wis.
Fuel Economizer Co., Matteawan, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
National Pipe Bending Co., New Haven, Conn.
Taunton Locomotive Mfg. Co., Taunton, Mass.
Robt. Wetherill & Co., Chester, Pa.
Whitlock Coil Pipe Co., Elmwood, Conn.

Feed-Water Purifiers.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hoppes Manufacturing Co., Springfield, Ohio.

Fertilizer Machinery.
Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Stedman's Foundry & Mch. Works, Aurora, Ind.

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Filters.
Morison-Jewell Filtration Co., 26 Cortlandt St., N.Y.

Fire Hydrants.
R. D. Wood & Co., Philadelphia, Pa.

Flexible Shafts.
Chicago Flexible Shaft Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.
T. H. Brooks & Co., Cleveland, Ohio.

Flour-Mill Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.

Fly Wheels.
Edw. P. Allis Co., Milwaukee, Wis.

Forges.
Buffalo Forge Co., Buffalo, N. Y.
Montgomery Company, 105 Fulton St., New York.
B. F. Sturtevant Co., Boston, Mass.

Forgings, Iron and Steel.
Chester B. Albree, Allegheny, Pa.

Forming Machines.
Long & Allstatter Co., Hamilton, Ohio.

Friction Clutches.
Eastern Machinery Co., New Haven, Conn.

Furnace Builders.
Julian Kennedy, Pittsburg, Pa.

Furniture.
Globe Company, Cincinnati, Ohio.

Furniture and Chair Machinery.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Gages—Pressure, Steam, Water, etc.
Bristol Co., Waterbury, Conn.
Montgomery Company, 105 Fulton St., New York.
Walworth Manufacturing Co., Boston, Mass.

Gas Fixtures.
Walworth Manufacturing Co., Boston, Mass.

Gas Holders.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gaskets.
Peerless Rubber Mfg. Co., 16 Warren St., New York.

Gas Machines and Generators.
American Gas Furnace Co., 23 John St., New York.
United Gas Improvement Co., Philadelphia, Pa.
Walworth Manufacturing Co., Boston, Mass.

Gas Plants.
American Gas Furnace Co., 23 John St., New York.
United Gas Improvement Co., Philadelphia, Pa.

Gas Producers.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gas-Works Machinery.
R. D. Wood & Co., Philadelphia, Pa.
United Gas Improvement Co., Philadelphia, Pa.

Gate Valves.
Jenkins Brothers, 71 John Street, New York.
Lunkenheimer Co., Cincinnati, Ohio.
Walworth Manufacturing Co., Boston, Mass.

Gear Cutters.
E. W. Bliss Co., Brooklyn, N. Y.
Montgomery Company, 105 Fulton St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.

Gearing.
Edw. P. Allis Co., Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Montgomery Company, 105 Fulton St., New York.
Morse, Williams & Co., Philadelphia, Pa.
New Process Rawhide Co., Syracuse, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Girders.
Chester B. Albree, Allegheny, Pa.
Berlin Iron Bridge Co., East Berlin, Conn.

Grain Elevator Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Grates.
Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.
Chicago Flexible Shaft Co., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Montgomery Company, 105 Fulton St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Grips, Cable Railways.
Robt. Wetherill & Co., Chester, Pa.

Hangers—See Pulleys.

Heating and Ventilating Apparatus.
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., New York.
Walworth Manufacturing Co., Boston, Mass.

Helve Hammers.
Long & Allstatter Co., Hamilton, Ohio.

Hoisting Engines and Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
John F. Byers Machine Co., Ravenna, Ohio.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Sherriff, Swingley & Co., 120 Liberty St., N. Y.
Stearns Manufacturing Co., Erie, Pa.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.

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Hollow Bricks.
Henry Maurer & Son, 420 East 23d St., New York.
Pittsburgh Terra Cotta Lumber Co., Pittsburg, Pa.

Hydrants.
R. D. Wood & Co., Philadelphia, Pa.

Hydraulic Cement.
Atlas Cement Co., 143 Liberty St., New York.

Hydraulic Machinery.
John H. McGowan Co., Cincinnati, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Ice Plants.
Westinghouse Machine Co., Pittsburg, Pa.

Ice-Making Machinery.
Frick Company, Waynesboro, Pa.
H. B. Roelker, 41 Maiden Lane, New York.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.

Indicators, Steam-Engine.
Queen & Co., Inc., Philadelphia, Pa.

Injectors.
American Injector Co., Detroit, Mich.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.
Wm. Sellers & Co., Philadelphia, Pa.

Industrial Railways.
C. W. Hunt Co., 45 Broadway, New York.

Insulated Wire.
Okonite Co., Ltd., 253 Broadway, New York.

Iron.
Passaic Rolling Mill Co., Passaic, N. J.

Joists, Iron and Steel.
Chester B. Albree, Allegheny, Pa.
Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Kiers.
Atlantic Works, East Boston, Mass.

Kyanizing.
Otis Allen & Son, Lowell, Mass.

Lamps, Electric.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.
W. F. & John Barnes Co., Rockford, Ill.
E. W. Bliss Co., Brooklyn, N. Y.
Bradford Mill Co., Cincinnati, Ohio.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Hamilton Machine Tool Co., Hamilton, Ohio.
Jones & Lamson Machine Co., Springfield, Vt.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Montgomery Company, 105 Fulton St., New York.
Niles Tool Works, Hamilton, Ohio.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Link Belting.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Locomotives.
Baldwin Locomotive Works, Philadelphia, Pa.
John F. Byers Machine Co., Ravenna, Ohio.
Pittsburg Locomotive Works, Pittsburg, Pa.
H. K. Porter & Co., Pittsburg, Pa.
Stearns Manufacturing Co., Erie, Pa.

Locomotive Brakes.
Westinghouse Air Brake Co., Pittsburg, Pa.

Lubricants.
Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.

Machine Screws.
Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.
Acme Machinery Co., Cleveland, Ohio.
W. F. & John Barnes Co., Rockford, Ill.
E. W. Bliss Co., Brooklyn, N. Y.
Bradford Mill Co., Cincinnati, Ohio.
Chicago Flexible Shaft Co., Chicago, Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Hilles & Jones Co., Wilmington, Del.
Jones & Lamson Machine Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Hamilton Machine Tool Co., Hamilton, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Montgomery Co., 105 Fulton St., New York.
Niles Tool Works, Hamilton, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Q & C Company, Chicago, Ill.
Wm. Sellers & Co., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Standard Tool Co., Cleveland, Ohio.
Stearns Manufacturing Co., Erie, Pa.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Strange Forged Twist Drill Co., New Bedford, Mass.
Toledo Machine & Tool Co., Toledo, Ohio.
Walworth Manufacturing Co., Boston, Mass.
Worcester Machine Screw Co., Worcester, Mass.

Marine Machinery.
Lambert Hoisting Engine Co., Newark, N. J.

Mathematical Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.,
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc., Philadelphia, Pa.

Merchant Steel.
Wm. Jessop & Sons, Ltd., 91 John St., New York.

Metals.
Wm. Jessop & Sons, Ltd., 91 John St., New York.
Merchant & Co., Inc., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Metal Lath.
Cincinnati Corrugating Co., Piqua, Ohio.

Metal Punching and Shearing.
Harrington & King Perforating Co., Chicago, Ill.

Meters, Electric.
Ft. Wayne Electric Corporation, Ft. Wayne, Ind.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

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Milling Machines.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Mine Cars.
Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, New York.

Mining Machinery.
Bradley Pulverizer Co., Boston, Mass.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
Fraser & Chalmers, Chicago, Ill.
Gates Iron Works, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lambert Hoisting Engine Co., Newark, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., New York.
John H. McGowan Co., Cincinnati, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, New York.
Sheriff, Swingley & Co., 120 Liberty St., N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Mining Screens.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.
American Engine Co., Bound Brook, N. J.
H. B. Coho & Co., 203 Broadway, New York.
Ft. Wayne Electric Corporation, Ft. Wayne, Ind.
Jeffrey Mfg. Co., Columbus, Ohio.
B. F. Sturtevant Co., Boston, Mass.
Thresher Electric Co., Dayton, Ohio
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Naphtha Gas Machines.
American Gas Furnace Co., 23 John St., New York.

Nickel.
Canadian Copper Co., Cleveland, Ohio.
Orford Copper Co., 37 Wall St., New York.

Office Furniture.
Globe Company, Cincinnati, Ohio.

Oil Cups.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, Ohio.
Montgomery Company, 105 Fulton St., N. Y.
Walworth Manufacturing Co., Boston, Mass.

Oil-Gas Plants.
American Gas Furnace Co., 23 John St., New York.

Oil Separators.
A. A. Griffing Iron Co., 66-68 Center St., New York.
Harrison Safety Boiler Works, Philadelphia, Pa.

Ore-Dressing Machinery.
Cuninghame & Co., Cincinnati, O.

Ore-Roasting Machinery.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.

Ornamental Iron Work.
Chester B. Albree, Allegheny, Pa.
Winslow Bros. Co., Chicago, Ill.

Packing.
Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., New York.
Montgomery Co., 105 Fulton St., New York.
New York Belting & Packing Co., Ltd., New York.
Peerless Rubber Mfg. Co., 16 Warren St., New York.

Paints.
Detroit Graphite Mfg. Co., Detroit, Mich.
Joseph Dixon Crucible Co., Jersey City, N. J.

Paper-Mill Machinery.
Jeffrey Mfg. Co., Columbus, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Pattern-Makers' Machinery.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Penstocks.
Atlantic Works, East Boston, Mass.

Perforated Metals.
Harrington & King Perforating Co., Chicago, Ill.

Phosphor Bronze.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Photographic Supplies.
Queen & Co., Inc., Philadelphia, Pa.

Pipe, Cast Iron.
Jeanesville Iron Works, Jeanesville, Pa.
McNeal Pipe & Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
Walworth Manufacturing Co., Boston, Mass.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.
National Pipe Bending Co., New Haven, Conn.

Pipe, Coverings.
Michigan Pipe Co., Bay City, Mich.

Pipe-Cutting and -Threading Machines.
Armstrong Mfg. Co., Bridgeport, Conn.
Walworth Manufacturing Co., Boston, Mass.

Pipe Dies.
Walworth Manufacturing Co., Boston, Mass.

Pipe Fittings, Cast-Iron.
Walworth Manufacturing Co., Boston, Mass.

Pipe, Spiral Riveted.
Abendroth & Root Mfg. Co., 28 Cliff St., New York.

Pipe, Wrought-Iron.
Walworth Manufacturing Co., Boston, Mass.

Planers.
Hilles & Jones Co., Wilmington, Del.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Planing Mill Machinery.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.

Plumbers' Tools and Supplies.
Walworth Manufacturing Co., Boston, Mass.

Portable Railways.
C. W. Hunt Co., 45 Broadway, New York.

Portland Cement.
Atlas Cement Co., 143 Liberty St., New York.

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Power Hammers.
E. W. Bliss Co., Brooklyn, N. Y.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Power Punches and Shears.
E. W. Bliss Co., Brooklyn, N. Y.
Hilles & Jones Co., Wilmington, Del.
Montgomery Company, 105 Fulton St., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Power-Transmission Machinery.
Filer & Stowell Co., Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.
Triumph Electric Co., Cincinnati, Ohio.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Preservation of Lumber.
Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic, etc.
Ferracute Machine Co., Bridgeton, N. J.
Niles Tool Works, Hamilton, Ohio.
Toledo Machine & Tool Co., Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Prospecting Drills.
American Well Works, Aurora, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulley Covers.
Shultz Belting Co., St. Louis, Mo.

Pulleys, Shafting and Hangers.
Edw. P. Allis Co., Milwaukee, Wis.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Montgomery Company, 105 Fulton St., New York.
Wm. Sellers & Co., Philadelphia, Pa.
Robert Wetherill & Co., Chester, Pa.

Pulverizers.
Bradley Pulverizer Co., Boston, Mass.
Stedman's Foundry & Machine Co., Aurora, Ind.

Pumps and Pumping Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., New York.
Deane Steam Pump Co., Holyoke, Mass.
Filer & Stowell Co., Milwaukee, Wis.
Gates Iron Works, Chicago, Ill.
A. A. Griffing Iron Co., 66-68 Center St., New York.
Guild & Garrison, Brooklyn, N. Y.
Hall Steam Pump Co., Pittsburg, Pa.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeanesville Iron Works, Jeanesville, Pa.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
John H. McGowan Co., Cincinnati, Ohio.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Wm. E. Quimby, 120 Liberty St., New York.
Stillwell-Bierce & Smith-Vaile Co., Dayton, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Punching and Shearing Machinery.
Long & Allstatter Co., Hamilton, Ohio.

Quarrying Machinery.
John F. Byers Machine Co., Ravenna, Ohio.
A. S. Cameron Steam Pump Works, E. 23d St., N.Y.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 100 Broadway, New York.
John H. McGowan Co., Cincinnati, Ohio.
Sherriff, Swingley & Co., 120 Liberty St., New York.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiator Screens.
Harrington & King Perforating Co., Chicago, Ill.

Radiators.
H. B. Smith Co., 137 Center St., New York.

Railroad Ditchers.
Jeffrey Mfg. Co., Cleveland, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Railway-Car Brakes.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railway Feed Wires.
Okonite Co., Ltd., 253 Broadway, New York.

Railway Shop Machinery.
Chester B. Albree, Allegheny, Pa.
Armstrong Mfg. Co., Bridgeport, Conn.
W. F. & John Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Chicago Flexible Shaft Co., Chicago, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Egan Co., Cincinnati, Ohio.
J. A. Fay & Co., Cincinnati, Ohio.
Hilles & Jones Co., Wilmington, Del.
Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.
Niles Tool Works, Hamilton, Ohio.
Norwalk Iron Works, South Norwalk, Conn.
Q & C Co., Chicago, Ill.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson & Stillman Co., 210 E. 43d St., New York.

Railway Specialties.
Harrington & King Perforating Co., Chicago, Ill.
H. K. Porter & Co., Pittsburg, Pa.
Q & C Co., Chicago., Ill.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railways, Portable.
C. W. Hunt Co., 45 Broadway, New York.

Rawhide Pinions.
New Process Rawhide Co., Syracuse, N. Y.

Reducing Valves.
Koss Valve Co., Troy, N. Y.

Refrigerating Machinery.
Frick Company, Waynesboro, Pa.

Riveting Machines.
Chester B. Albree, Allegheny, Pa.
Montgomery Company, 105 Fulton St., N. Y.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Road-Making Machinery.
O. S. Kelly Co., Springfield, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

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Road Rollers.
O. S. Kelly Co., Springfield, Ohio.

Rock Breakers.
Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Gates Iron Works, Chicago, Ill.

Rock Drills.
M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Works, 26 Cortlandt St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 100 Broadway, New York.
Sullivan Machinery Co., Chicago, Ill.

Roofing.
Berlin Iron Bridge Co., East Berlin, Conn.
Cincinnati Corrugating Co., Piqua, Ohio.
Merchant & Co , Inc., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.

Roofs, Iron Truss.
Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Rope Transmission.
C. W. Hunt Co., 45 Broadway, New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Philadelphia, Pa.

Rubber Goods.
Boston Belting Co., Boston, Mass.
Jenkins Brothers, 71 John St., New York.
New York Belting & Packing Co., Ltd., New York.

Saw-Mill Machinery.
Edw. P. Allis Co., Milwaukee, Wis.
Chandler & Taylor Co., Indianapolis, Ind.
Filer & Stowell Co., Milwaukee, Wis.

Schools.
Bliss School of Electricity, Washington, D. C
Correspondence School of Technology, Cleveland, Ohio.
International Correspondence Schools, Scranton, Pa.

Screens, Mining.
Gates Iron Works, Chicago, Ill.
Harrington & King Perforating Co , Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Screen Plates, Punched.
Harrington & King Perforating Co., Chicago, Ill.

Screw Machines.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Jones & Lamson Machine Co., Springfield, Vt.
Montgomery Company, 105 Fulton St., New York.
Niles Tool Works, Hamilton, Ohio.

Separators, Coal and Ore.
F. D. Cummer & Son Co., Cleveland, Ohio.

Separators, Steam.
A. A. Griffing Iron Co., 66-68 Center St., New York.
Harrison Safety Boiler Works, Philadelphia, Pa.
Taunton Locomotive Mfg. Co., Taunton, Mass.

Shafting (see Pulleys).

Shaping Machines.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Wm. Sellers & Co., Inc., Philadelphia, Pa.

Sheet-Metal Tools.
E. W. Bliss Co., Brooklyn, N. Y.
Toledo Machine & Tool Co., Toledo, Ohio.

Shoes and Dies.
Chrome Steel Works, Brooklyn, N. Y.
Gates Iron Works, Chicago, Ill.

Smokestacks.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.

Spark Guards, Perforated.
Harrington & King Perforating Co., Chicago, Ill.

Steam Loops.
Westinghouse Machine Co., Pittsburg, Pa.

Steam-Regulating Appliances.
Detroit Lubricator Co., Detroit, Mich.
Harrison Safety Boiler Works, Philadelphia, Pa.
Jenkins Brothers, 71 John St., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Co , Cleveland, Ohio.
Ross Valve Co., Troy, N. Y.
B. F. Sturtevant Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Steamships and Towboats.
Atlantic Works, East Boston, Mass.

Steam Shovels.
Marion Steam Shovel Co , Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Steam Traps.
American Blower Co., Detroit, Mich.
American Impulse Wheel Co., 120 Liberty St., New York.
Buffalo Forge Co., Buffalo, N. Y.
A. A. Griffing Iron Co., 66-68 Center St., New York.
B. F. Sturtevant Co., Boston, Mass.
Walworth Manufacturing Co., Boston, Mass.

Steel Importers.
Hobson, Seaman & Co , 97 John St., New York.
Wm. Jessop & Sons, Ltd., 91 John St., New York.

Steel Manufacturers.
Chrome Steel Works, Brooklyn, N. Y.
Hobson, Seaman & Co., 97 John St., New York.
Wm. Jessop & Sons, Ltd., 91 John St., New York.
Passaic Rolling Mill Co., Paterson, N. J.

Stokers.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Westinghouse Machine Co., Pittsburg, Pa.

Storage Batteries.
Electric Storage Battery Co., Philadelphia, Pa.

Structural Iron Work.
Chester B. Albree, Allegheny, Pa.
Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.

Sugar-House Machinery.
R. D. Wood & Co., Philadelphia, Pa.

Surveying Instruments.
Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc , Philadelphia, Pa.

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Tanks, Iron.
Atlantic Works, East Boston, Mass.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Pittsburg Locomotive Works, Pittsburg, Pa.
Taunton Locomotive Mfg. Co., Taunton, Mass,

Telegraph Wires and Cables.
John A. Roebling's Sons Co., Trenton, N. J.
Okonite Co., 13 Park Row, New York.

Testing Machinery.
Wm. Sellers & Co , Philadelphia, Pa.

Thermometers.
Bristol Co., Waterbury, Conn.
Queen & Co., Inc., Philadelphia, Pa.

Tie Plates.
Q & C Co., Chicago, Ill.

Tin.
Merchant & Co., Inc., Philadelphia, Pa.

Tire-Welding Machine.
Long & Allstatter Co., Hamilton, Ohio.

Tramways.
C. W. Hunt Co , 45 Broadway, New York.

Tramways, Wire Rope.
Cooper, Hewitt & Co., 17 Burling Slip, New York.
Fraser & Chalmers, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, New York.
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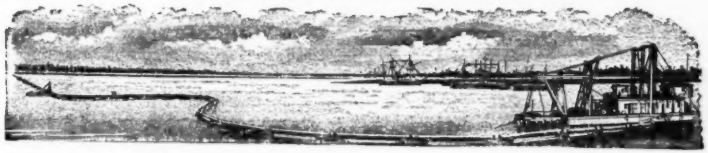

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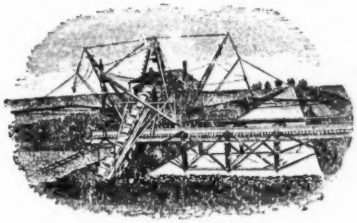

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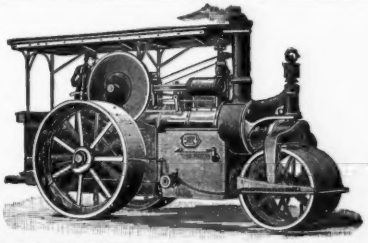

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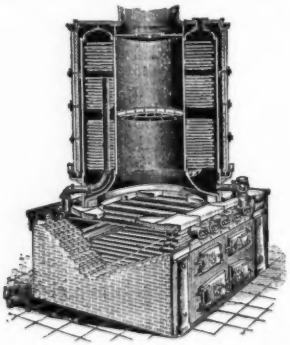

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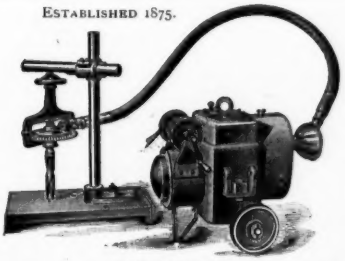

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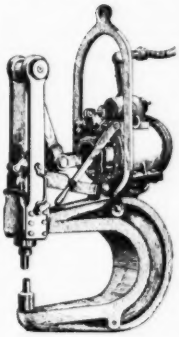

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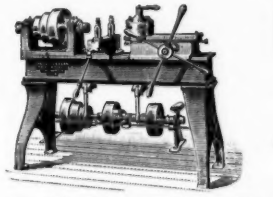

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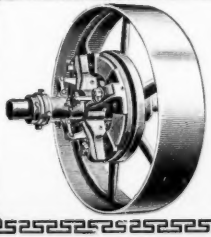

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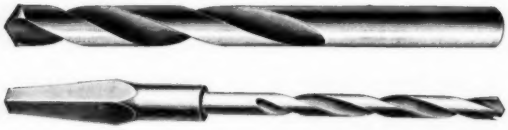

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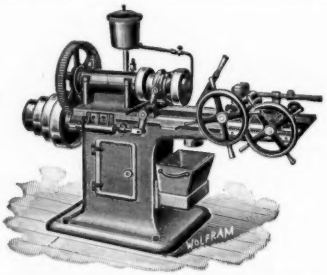

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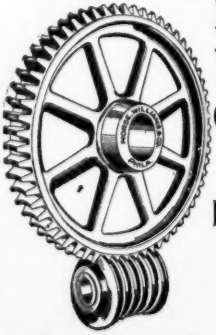

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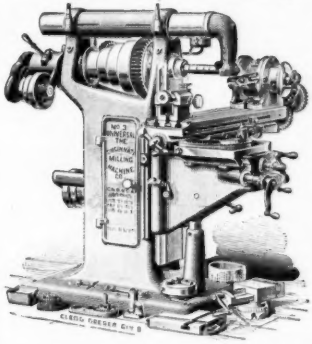

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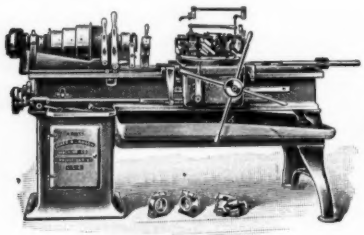

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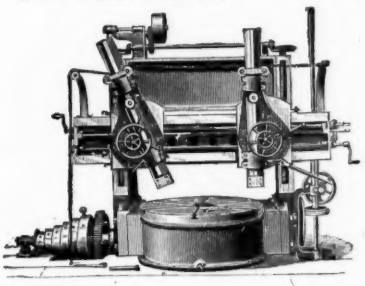

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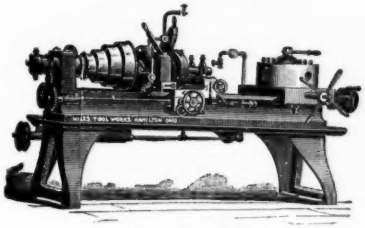

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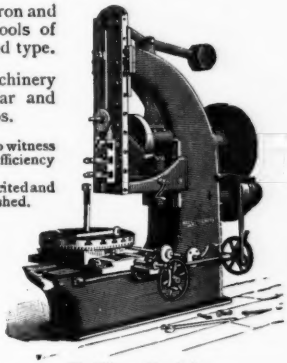

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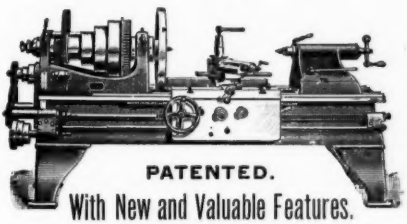

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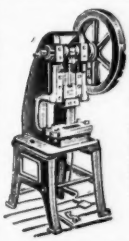

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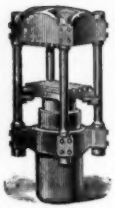

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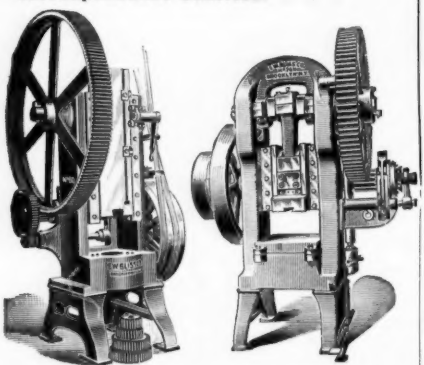

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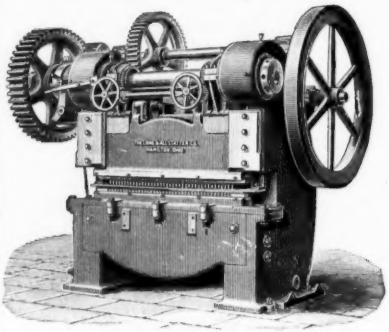

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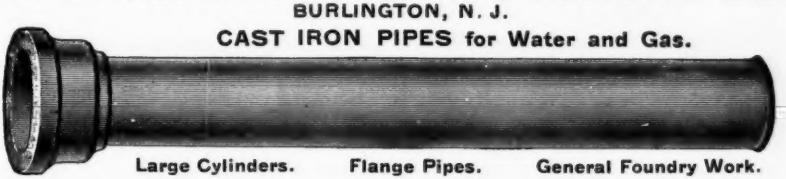

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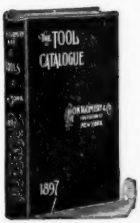

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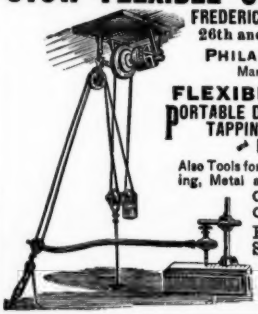

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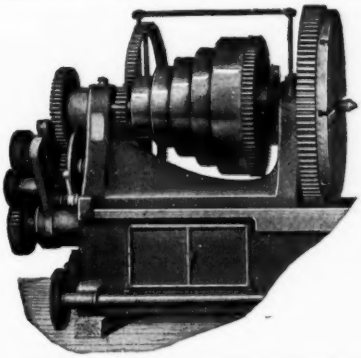

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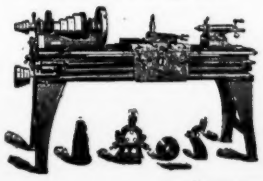

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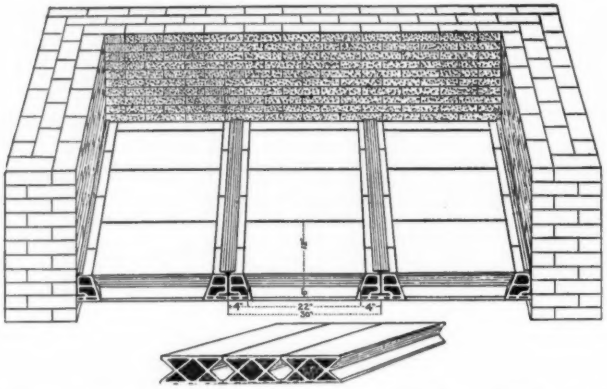

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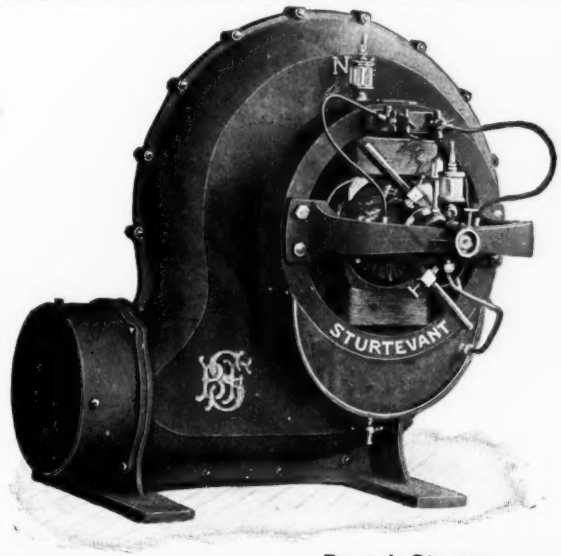

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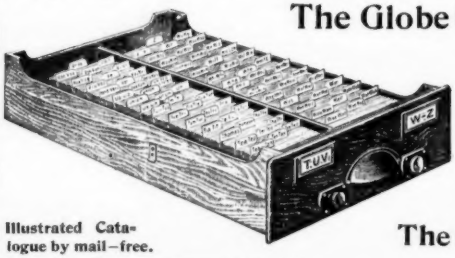

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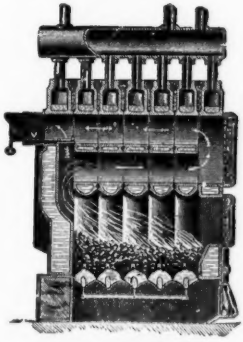

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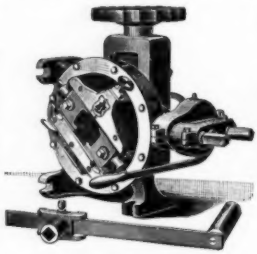

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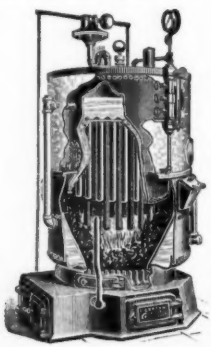

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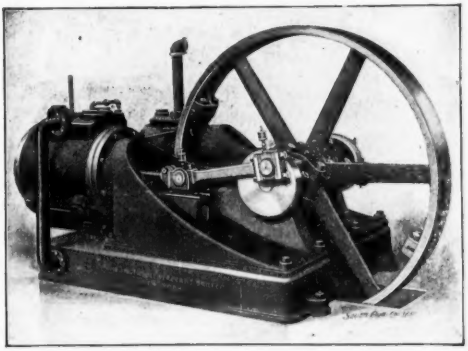

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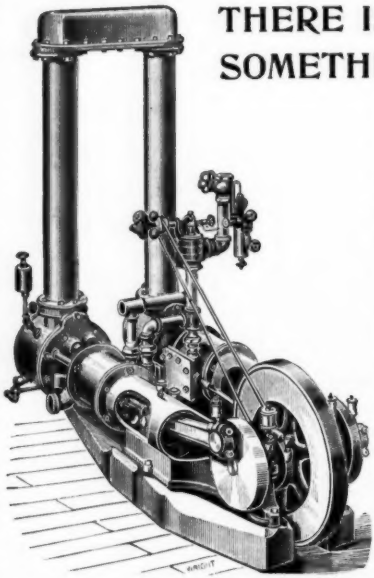

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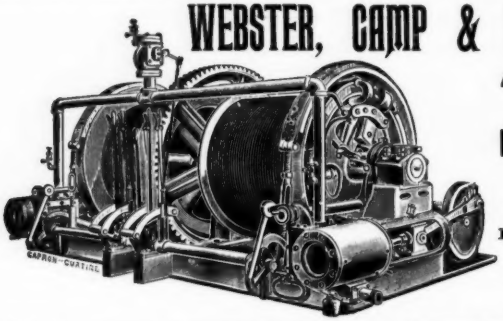

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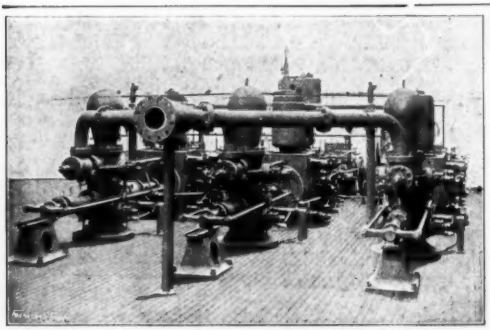

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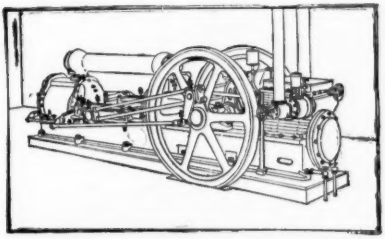

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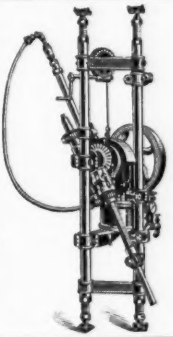

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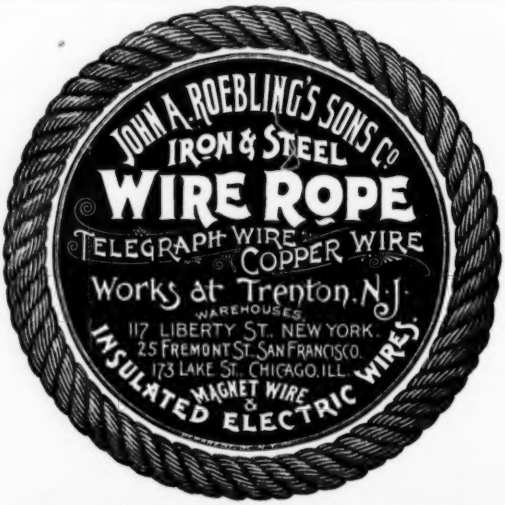

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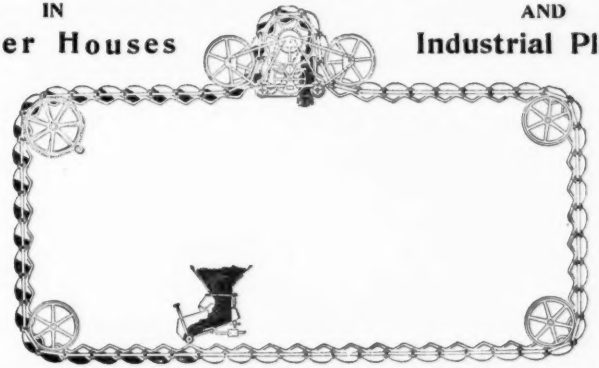

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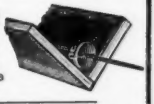

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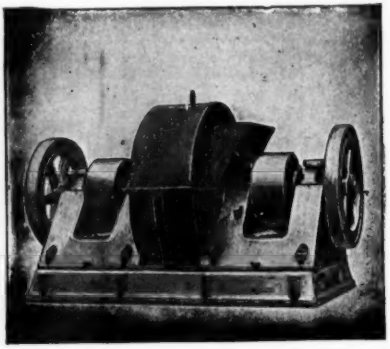

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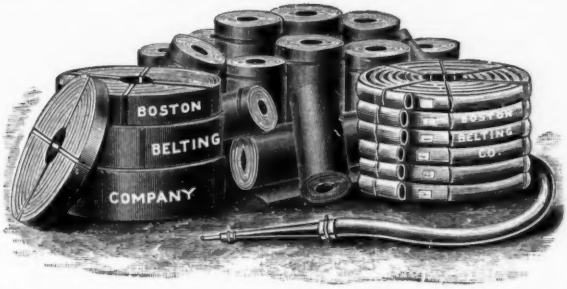

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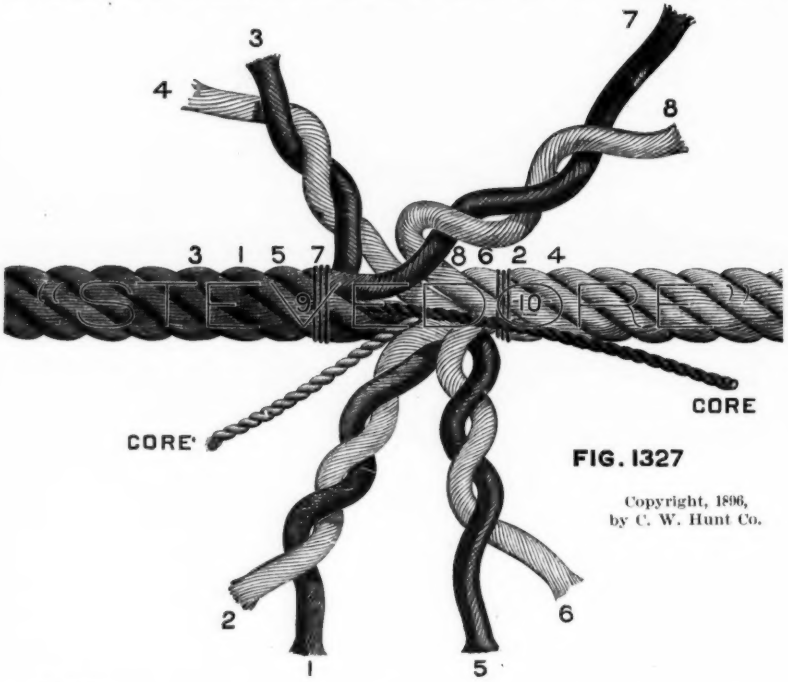

FIG. 1327

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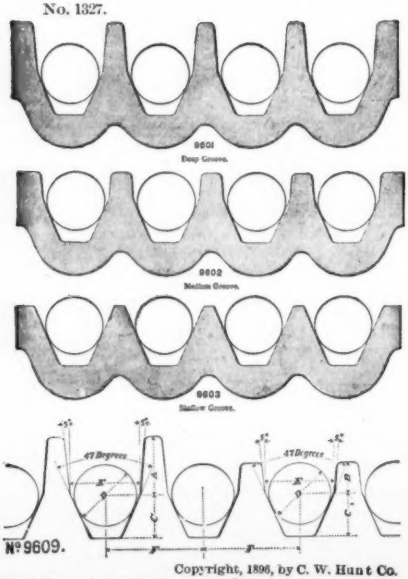

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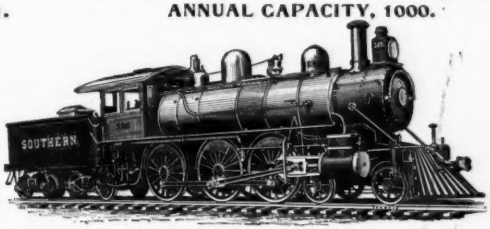

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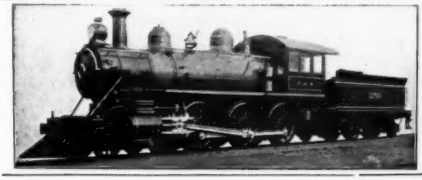

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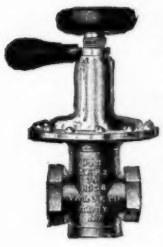

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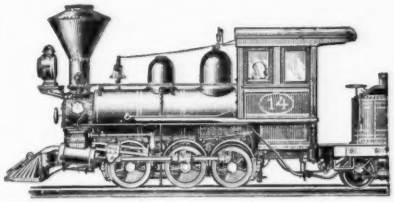

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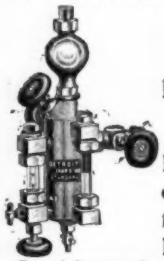

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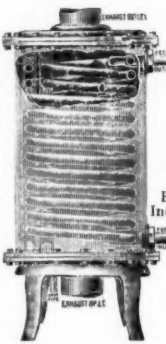

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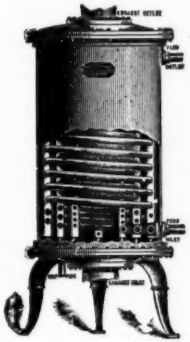

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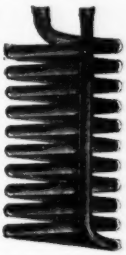

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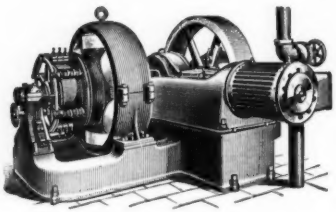

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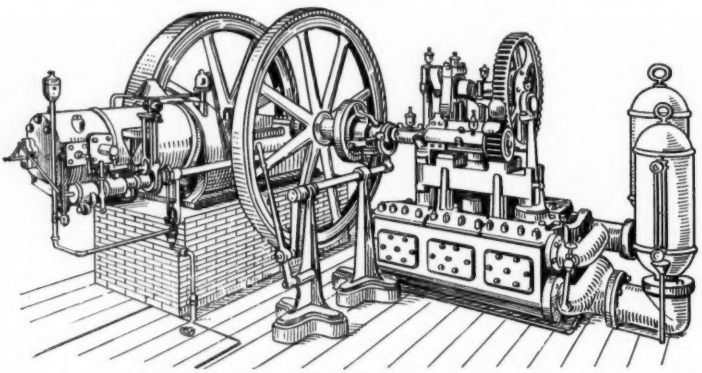

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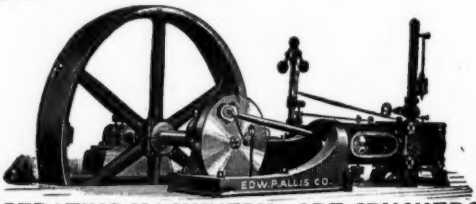

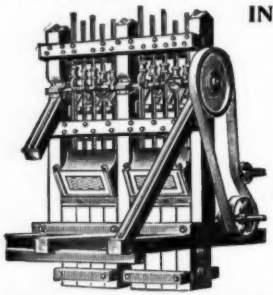

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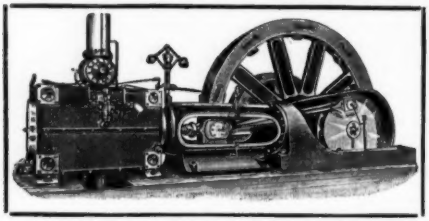

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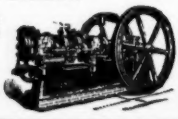


IMPROVED MACHINERY

NEW PROCESSES—NEW APPLIANCES

The matter published in this department is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

The Gates Rock Breaker.

ROCK breakers may be broadly divided into two clases—those which crush the material between flat jaws, and those with curved surfaces between which the breaking is done either by rolling or eccentric action. The Gates Gyratory Rock Breaker, made by the Gates Iron Works, of Chicago, belongs to the latter class, and its general construction will be understood from the illustration.

A GATES ROCK BREAKER.

The term "gyratory" itself partly explains the construction, as the crushing is performed by a cone placed on a gyratory shaft in a vertical position in the centre of a cylindrical shell. As the shaft gyrates, the crushing cone impinges against the sides of the shell, in relation to which it is constantly approaching and receding. The top of the shaft carrying the crushing cone is rigidly held while the bottom is gyrated with a certain amount of eccentricity, depending upon the size of the machine, by means of a simple gearing.

The nature of the crushing surfaces in this construction is such that the pieces of rock are in contact with the outer shell only at their extremities while the crushing cone is forced against intermediate points, giving an advantageous action to the crushing force. The conical shape of the crushing head gives a constantly-increasing space for the crushed material as it descends, thus reducing the liability of choking or packing, and the strength and power of the machines is such as to enable a very large output of work to be obtained.

As an example of the capabilities of this machine, it may be noted that a No. 8 Gates Breaker in use by the Pittsburg Limestone Co., Ltd., during the fourteen months between July 1st, 1896, and August 31st, 1897, crushed 23,174 car-loads of limestone, this corresponding to over 180 tons per hour, ten hours a day, for fourteen months.

These crushers are in extensive use in all parts of the world for crushing ore, rock, and other material, and have proved very successful in practice.

The Prevention of Electrolysis

ELECTROLYSIS, as an agency destructive to water-pipes, has engaged the attention of so many engineers and electricians that especial attention attaches to the relief, promised by the makers of the Wyckoff pipe, illustrated on this page.

The claim is well supported by the experience gained in three large systems, notably in that of Bay City, Michigan, which has recently been reviewed in the Bay City *Tribune*, from which we quote:

"The citizens of Bay City can congratulate themselves upon the fact that there is but little danger to Bay City's water pipes from electrolysis, because the pipes are almost all improved Wyckoff water pipes with thick wooden shells. The metal used in the bands for strengthening the pipes is insulated by the thick coating of pitch which covers them. There is no continuous metallic path for electricity, as the banding in each length is separated by a space of about one inch. A careful

THE WYCKOFF PIPE.

inqu'ry shows that not a foot of Wyckoff pipe has ever been damaged by electrolysis. This city has about 35 miles of the improved Wyckoff water pipe in its system, the first of it having been laid in 1872. A large system at North Tonawanda and Tonawanda, N. Y., contains about 45 miles of improved Wyckoff pipe, the first of which was laid in 1886. The pipe in the Tonawandas shows no damage from electrolysis, notwithstanding the

fact that these two towns have four street railroads. Ishpeming, Mich., has a system of water works employing about 28 miles of Wyckoff pipe. The soil at Ishpeming is full of metallic salts, which is a favorable condition for electrolytic action on iron pipe, yet the Wyckoff pipe in that city has never been affected."

"The destruction to cast-iron water mains from the effects of electrolysis is noticed at length in newspapers published in cities where cast iron pipe is used in the distributing systems. It seems that the return currents of electricity in street-railroad rails leak off from the rails and, in seeking the easiest path back to the dynamo, follow along lines of cast-iron water mains. The action of the electric current upon the water decomposes it into its elements, oxygen and hydrogen, oxydizing or rusting the iron; but by far the greater damage is done by the current actually carrying part of the cast iron pipe and depositing the metal on the rail or other metallic conductor on its return, leaving the pipe pitted and, of course, much weakened.

"It is authoritatively stated that the cast-iron water pipes of Chicago have been damaged fully one third of their value by electrolysis. Brooklyn, at a great expense, caused an electrical survey to be made to determine the extent of the injury to water pipes and, if possible, devise a plan to prevent further damage. In this survey a locality was found in which iron pipe was destroyed in about six months' time.

"One water company in California, despairing of getting relief from any devices yet proposed by experts, has sought relief in the courts by bringing action against the offending street railroad company."

The Wyckoff pipe is made by The Michigan Pipe Company, Bay City, Mich., who will furnish additional information to any interested inquirer.

SEXTON'S OMNIMETRE.

Sexton's Omnimetre.

THE importance and value of the slide rule as an instrument for facilitating computations, saving labor, and insuring accuracy, is so well known among engineers and mechanics as to need no restatement here.

Sexton's Omnimetre, sold by Messrs. Theodore Alteneder & Sons, of Philadelphia, is an improved form of slide rule, which possesses many advantages, and has been found in practice to be greatly superior in scope and accuracy to the customary form of straight rule.

As shown in the illustration above, which repre-

sents the instrument about one-half size, the Omnimetre is a circular slide rule, consisting of two concentric disks and a radial arm or runner, corresponding to the slide runner of the ordinary Manheim rule.

The upper, or rotating, disk contains circles of numbers, squares, cubes, fifth powers, sines, tangents, secants, and versed-sines; while the lower, or stationary, disk contains a circle of numbers and one of logarithms.

The circumferences of these circles about correspond in length to those of a twenty-inch straight rule, and the divisions are so open that very precise readings may be made. All mathematical operations usually performed by the aid of tables of logarithms and of trigonometrical functions can readily be done on the Omnimetre, including all arithmetical processes except addition and subtraction.

The most complicated formulæ can be solved easily by its aid, without requiring any special training, any problem which can be stated in the shape of a formula being capable of solution on the Omnimetre. The graduation of the various scales is remarkably fine, being performed on a dividing engine constructed especially for the purpose, and is vastly superior to that of any straight rule yet made.

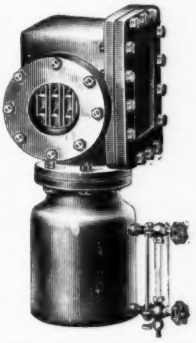
Since its introduction, a little over a year ago, the Omnimetre has made its way rapidly into use in the offices of engineers and manufacturing establishments, and is also much used by students in such educational institutions as Cornell, University of Pennsylvania, Massachusetts Institute of Technology, and many others.

The simplicity of the Omnimetre as compared with some of the elaborate calculating machines which cannot render anything like such a variety of service, and its moderate cost in comparison with that of straight slide rules of inferior accuracy, render it a valuable addition to the family of mental-labor-saving devices, and it should find a place in every engineering and manufacturing office, and in all places where computations are frequently made.

Bundy Steam and Oil Separator With Side Flange.

THE importance of frequent cleaning of a separator, and especially an oil separator, is as marked as the need of thorough working, and the one is dependent upon the other; in the matter of making a selection one should consider carefully this convenience. There are very many places in which there is not sufficient headroom for the removal of the baffle plates of a separator, even though it is constructed with such plates. This apparent need has caused the makers of the Bundy separator to produce one with the side flange, through which the baffle plates way be slipped with perfect ease.

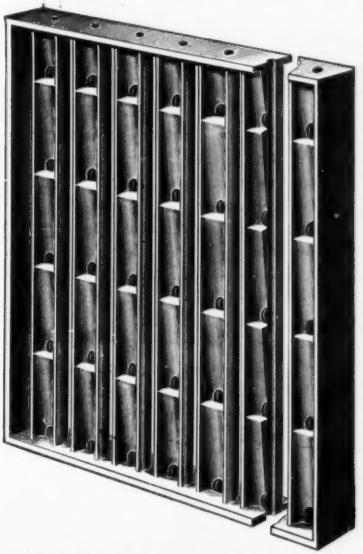
This separator is interchangeable, that is, it may be put in so that the side flange may be on either side; but care must be used to see that the baffle plates are put in so that their flat front may face the incoming steam, as this side alone has the capillary openings through which the oil and water may enter and go to the receiver below by gravity action.



THE BUNDY SEPARATOR.

The rear side of the Bundy-separator baffle plate shows the vertical posts, rounded for the easy passing of the steam. They are so constructed that the posts are set staggered to each other—in other words, a post in one baffle plate is set directly back of a space in the plate in front of it, causing the steam to pass through in a zig-zag course.

It is hardly necessary to reiterate the maker's claim that the Bundy separator is particularly well adapted for marine use, where, however, the side-flange type is almost invariably required. This style is made in all sizes from 2 inch up to and inclucing 24 inch. Further particulars can be ob-



BAFFLE PLATE OF THE BUNDY SEPARATOR.

tained from the makers, the A. A. Griffing Iron Co., 66–68 Centre St., New York, or 177–179 Fort Hill Sq., Boston, Mass., or 702 Arch St., Philadelphia, Pa. Their works are at Jersey City, N. J. They send on application a handsome book, entitled "Sure Cure for Wet or Oily Steam."

A Large Order for Mining Machinery.

Messrs. Fraser & Chalmers, Chicago, have recently booked what is said to be one of the largest single orders ever placed for mining machinery. The purchase was made for the Alaska Treadwell properties, and the principal details of the machinery contracted for are as follows:

One 300-stamp mill complete, stamps weighing 1,050 pounds each, with 120 six-foot Frue vanners, two adjustable Comet crushers "E" size; this mill to be run by water power.

One-120 stamp mill complete, stamps weighing 1,050-pounds each, with 48 six-foot Frue vanners and one adjustable Comet crusher, "E" size; this mill to be run by a Fraser & Chalmers horizontal cross-compound condensing Corliss engine.

One 100-stamp mill complete, stamps weighing 1,050 pounds each, with 40 six-foot Frue vanners and one adjustable Comet crusher, "E" size; this mill to be run by water power.

The above makes a total of 520 stamps, 208 Frue vanners, 4 adjustable Comet crushers, "E" size.

In addition to the above plants of milling machinery, orders were placed for three large Fraser & Chalmers hoisting engines and a Riedler air compressor.

The weight of the machinery will be considerably above six million pounds (6,000,000 lbs.), and the contract price was about $450,000.

Commenting upon the sale, one of the Salt Lake, Utah, daily papers says:

"There was severe competition experienced from the principal manufacturers of mining machinery, both on the Pacific coast and elsewhere, and as price was not the only factor considered in awarding the contract, Mr. John W. Young, general western manager for Fraser & Chalmers, believes the decision was largely influenced by the fact that most of the directors were experienced mining men who have for years been familiar with the comparative merits of different designs and quality of mining machinery not only in the United States, but in Africa and South America; also by the fact that the Alaska Mexican 120-stamp mills, which have been in operation on their properties in Alaska for some years, have proved to be of such superior design and material that the directors felt they would incur no risks in having the new 520 stamps made on similar lines. The Frue vanners and adjustable Comet crushers were decided upon, as it was considered they represented the highest types of concentrating and crushing machines."

"During the past year extensive improvements and additions, both in buildings and tools, have been made to Fraser & Chalmers' Chicago works, and their facilities are now such that, without interference with their regular run of work, the large quantity of machinery represented by these Alaska contracts can be made and shipped quite as soon as the necessary buildings and foundations can be erected to receive it."

NEW CATALOGUES.

The Phœnix Foundry Co., Derby, England.=Well-illustrated 32-page catalogue of bridge and constructional iron work, with several photo-reproductions of actual structures; shows outline trusses for bridge and roof work, and gives full safe- and breaking-load tables, weights and inertias of the Hobson patent arch-plate system of flooring.

Albert E. Berry, Sowerby Bridge, England.=Comprehensive cloth-covered catalogue of wood-working machinery, with illustrations of each type of machine, dimensions, and telegraphic code words for ordering. A full line of all kinds of wood-working and box-making machinery is described in a clear and concise manner.

W. B. Haigh & Co., Globe Iron Works, Oldham, England.=(*a*) 8-page leaflet illustrating and giving efficiency tests of the McDougal mechanical stoker; (*b*) ditto illustrating McDougal's water and grease separator for dry steam, with complete description and list of sizes; (*c*) ditto illustrating McDougal's steam trap, with list of testimonials; (*d*) leaflet on McDougal's oil extractor and separator with over-all dimensions and prices; (*e*) leaflet on the McDougal anti-primer for fixing inside boilers; (*f*) catalogue with prices of lubricators made either in brass or aluminium.

The McCabe Manufacturing Co., New York.=Catalogue of tubular door-hangers, with patent ball bearings for use on sliding doors and overhead carrying of all kinds.

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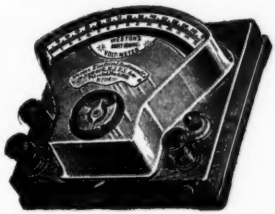

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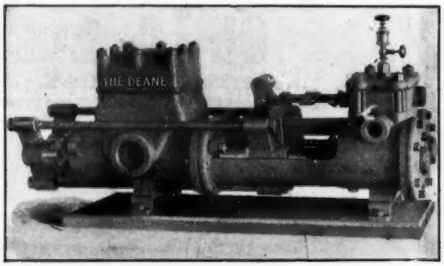

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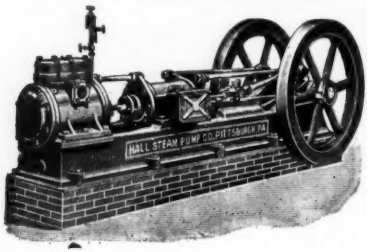

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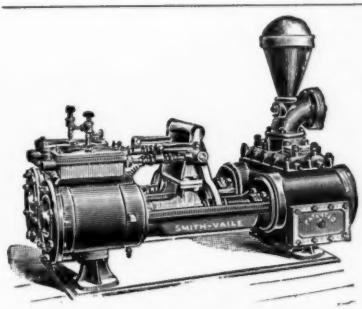

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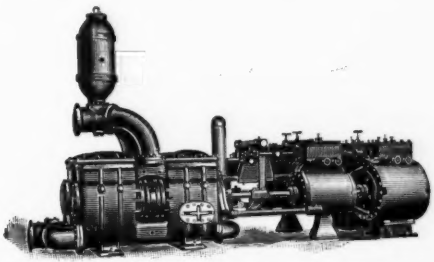

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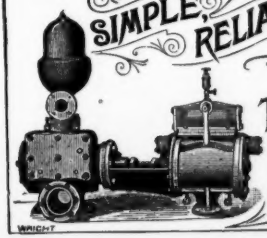

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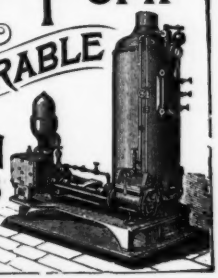

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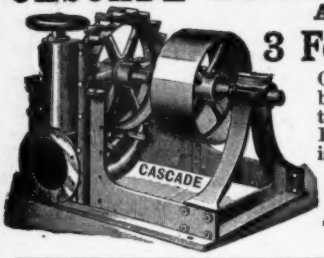

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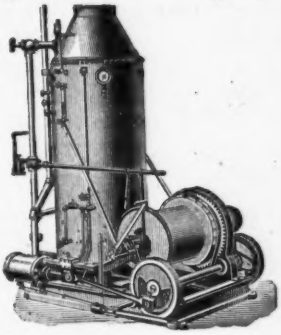

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